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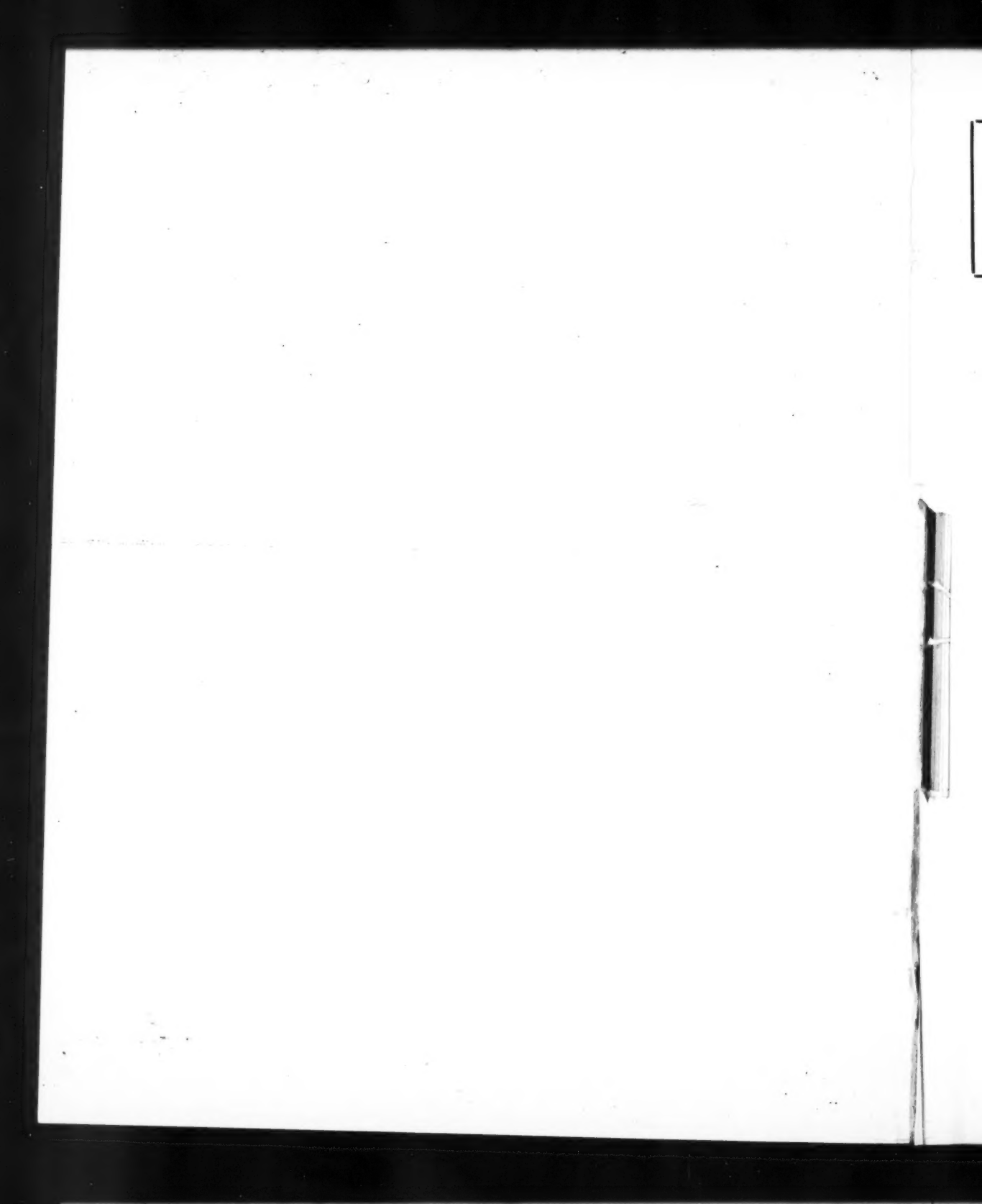

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INVESTIGATION ON THE CULTIVATION OF BAJRA
(Pennisetum typhoideum)

P. S. Tomer & R. R. Singh.

In the absence of scientific details on the cultural aspects of *Bajra*, the present way of its cultivation is rather primitive and is inadequate to make the crop yield satisfactory. The seed is, generally, sown broadcast, in rather a rough seed-bed with little or no manure. Under these conditions, naturally, the yields obtained are very low. In the cultivation of *Bajra* the method of sowing, the seedrate and the manuring are three important aspects which deserve consideration for maximising the yield per acre. With the above considerations a sowing methods-cum-seedrates-cum-manuring investigation, to produce *Bajra* at it's maximum, was undertaken.

Experimental technique :

At the B. R. Agricultural Research Station, Bichpuri, Agra, a 'single split plot' field experiment was laidout in the *Kharif* season of 1959 to test the effects of two methods of sowing (line and broadcast), 50 lb. N. per acre applied through compost and ammonium sulphate in whole and split doses—

(i) all N through ammonium sulphate at sowing,

(ii) all N through municipal compost at sowing,

(iii) half N as S/A + half N as municipal compost both at sowing,

(iv) 3/4 N as municipal compost at sowing + 1/4 N through S/A as top dress and two seedrates (one seer and two seers per acre).

Thus, there were, in all, 16 treatment combinations which were replicated three times. The experimental crop of *Bajra* (Isolated variety) which was sown on July 17, was taken after gram during the preceding *rabi* season.

After sowing of the crop, on 21st July a rainfall of 0.71″ occurred followed by 1.93″ and 0.30″ respectively on the next two days. This exerted a deleterious effect on the germination of the seeds due to crust formation, particularly in line sowing. The total amount of precipitation, during the crop life cycle, was 14.28″ which was nicely distributed.

The soil samples taken before applying the manures, from the experimental area, were subjected to chemical and mechanical analysis. The soil was light loam in texture, deficient in nitrogen (0.047%) and pretty rich in phosphorus (0.089%) and potash (1.080%).

Results and Discussion :

The yield data were subjected to statistical analysis, and the results are summarised in the tables below :

TABLE I

Effect of two sowing methods on the grain and stover yields of *Bajra.*

Sowing methods	Grain yield/acre lb.	Stover yield/acre lb.
Line sowing (M_1)	1,424.8	7,629.0
Broadcast sowing (M_2)	1,656.5	8,863.6
S. Em.	40.0	550.0
C. D. at 5%	Non-Sig.	Non-Sig.

It is seen from the table that the variations in the yield due to the methods of sowing, line and broadcast, were statistically non-significant. However, broad cast sowing showed a clear tendency to yield more grain and stover per acre than line sowing. These variations appear tohave been brought about by the variations in plant population at harvest which was significantly more in broadcast than line sowing (App. table I). Similar results were also obtained by Chavan (1958).

TABLE II

Effect of four manurial treatments on the grain and stover yields of *Bajra.*

Manurial treatments.	Grain yield/acre lb.	Stover yield/acre lb.
50 lb. N through S/A all at sowing time (F_1)	1,589.5	7,528.9
50 lb. N at sowing through compost (F_2)	1,434.2	9,064.9
25 lb. N through compost 2 + 5 lb. N through S/A both at sowing (F_3)	1,616.1	8,451.9
37. 5 lb. N through compost at sowing + 12.5 lb. N through S/A as top dress (F_4)	1522.6	7,939.9
S. Em.	60.8	421.9
C. D. at 5%	Non-Sig.	Non-Sig.

The results in both the cases were statistically non-significant. However, the application of total nitrogen at sowing, half through compost plus half through S/A, followed by the application of total nitrogen at sowing through S/A, proved better than the other two treatments in case of grain yield. While in the case of stover yield, the application of total nitrogen at sowing through compost, followed by total nitrogen at sowing, half through compost and half through S/A, showed a slight improvement over other two treatments. An examination of the data on plant population (App. Table I) suggests that the better performance of compost in stover production was caused, mainly, through variation in the plant stand.

TABLE III

Effect of two seed rates on grain and stover yields of *Bajra*.

Seedrates	Grain yield/ acre. lb.	Stover yield/ acre. lb.
1 seer / acre (S_1)	1,476.5	8,096.0
2 seers / acre (S_2)	1,604.7	8,396.6
S. Em.	37.8	298.3
C. D. at 5%	108.3	Non-Sig.

It is seen from the table that 2 seers seedrate gave significantly higher grain yield over 1 seer. The same trend was also noted in case of stover yield but the difference was statistically non-significant. Similar findings were those of Chavan (1958) and Sharma (1960).

TABLE IV

Interaction (sowing methods × seed rates) effects on the grain yield (lb./acre).

Seedrates.	Sowing Methods	
	Line (M_1)	Broadcast (M_2)
1 seer / acre (S_1)	1,292.8	1,660.2
2 seers / acre (S_2)	1,556.7	1,652.7
S. Em.	61.3	
C. L. at 5 %	175.3	

An examination of the results, in table IV, reveals that the yield of grain per acre was greater in broadcast sowing than in line sowing with both the seedrates; the difference being significant only in case of one seer. Further it is seen that in line sowing the yield was significantly greater with 2 seers than with 1 seer, while in case of broadcast the yields with the two seedrates did not differ much. The maximum yield was noted with the combination of broadcast sowing and 1 seer, seedrate, and the lowest with line sowing and 1 seer seedrate. The results are indicative of the fact that for good yields from line sowing a higher seedrate (2 seers) is necessary, while in broadcast sowing a lower seedrate (1 seer) is quite enough. This may be due to the fact that in line sowing, with the usual sowing devices, the chances for a good germination of the seed sown are minimised. Moreover, the occurrence of rain during the germination phase, this year, caused a set back to line sowing in the present experiment.

TABLE V

Interaction (seedrates × manurial treatments) effects on stover yield (lb./acre)

Seed rates	Manurial treatments			
	F_1	F_2	F_3	F_4
1 seer / acre (S_1)	7,813.0	8,869.1	7,015.0	8,686.8
2 seers / acre (S_2)	7,244.9	9,260.8	9,888.8	7,191.8
S. Em.		487.2		
C. D. at 5 %		993.5		

It is seen that the maximum yield of stover per acre (9,888.8 lb.) was obtained with the combination $S_2 F_3$ (2 seers seedrate and half nitrogen through compost + half nitrogen through S/A, both at sowing) and the minimum (7,015.0 lb) with $S_1 F_3$ (1 seer seedrate and half nitrogen through compost + half nitrogen through S/A both at sowing).

These results indicate that for maximum yield of stover the total nitrogen, should be applied at sowing half as S/A + half as compost along with 2 seers seedrate.

Summary and Conclusion :

An experiment was conducted at the B. R. Agricultural Research Station, Bichpuri, Agra in the Kharif season of 1959 to study the effects of two sowing

methods, four forms of nitrogen and two seedrates on grain and stover yields of *Bajra*, Isolated. The following main conclusions are drawn from the findings of this experiment.

(1) As judged from acre yields, broadcast sowing appears to be better than line sowing.

(2) For better yields total, 50 lb., N per acre may be applied at sowing, half through compost and half through S/A.

(3) A seed rate of 2 seers per acre may workout better than 1 seer seedrate to give requisite number of plants needed for a good crop.

(4) There were indications that in line sowing a higher seedrate is needed than in broadcast, because of poorer germination in the former case.

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1. Chavan, V. M. (1958) Agronomic improvements in bajra. Bajra cultivation in India, Farm Bull. No. 48, I. C. A. R., New Delhi. p.p. 29—33.

2. Sharma, K. C. (1960) Yield of bajra in relation to plant density. B. V. Jour. Agri. Sci. Res., Agra Vol. II No. 2 July, 1960.

APPENDIX—TABLE I

Plant population and survival percentage as affected by different treatments.

Treatments.	No. of plants / acre		% Survival
	on 30th day	at harvest	
Line sowing (M_1)	61,638	42,907	71.80
Broadcast sowing (M_2)	1,17,375	76,122	67.80
S. Em.	53	5,227	5.90
C. D. at 5 %	32,126	31,472	Non-Sig.
50 lb. N through S/A all at sowing time. (F_1)	88,536	58,698	71.90
50 lb. N through compost all at sowing time (F_2)	91,585	69,043	74.00
25 lb. N through compost plus 25 lb. N through S/A both at sowing (F_3)	77,319	56,955	74.50
37.5 lb. N through compost at sowing plus 12.5 lb. N through S/A as top dress (F_4)	1,02,475	53,470	58.90
S. Em.	10,128	5,989	5.60
C. D. at 5%	Non-Sig.	Non-Sig.	Non-Sig.
One seer seedrate/acre (S_1)	65,449	44,541	73.50
Two seers seedrate/acre (S_2)	1,14,563	74,488	66.20
S. Em.	7,187	4,138	3.90
C. D. at 5%	20,582	11,761	Non-Sig.

"EFFECT OF IRRIGATION WATER OF VARYING SALINITY ON VEGETABLE CROPS (Part II)"

R. R. Singh & O. P. Pachaury.

Introduction :

Growing of vegetables, specially near cities, is a profitable venture for the farmers. But successful production of vegetables depends on an assured supply of irrigation. In the Agra area, irrigation by canals, which being seasonal, cannot meet the full needs of vegetable crops. Additional sources of irrigation are surface wells, and in recent years deep (bore) wells are also being developed. But water from the deep wells, and in some cases from the surface wells also, are reported to be saline. The Balwant Rajput College farm, has a surface well, whose water has a salt content of 845 ppm and a 250 ft. deep tube well with a salt content of 1430 ppm. It was desired to study, whether some of the common vegetables, could be raised with the above water sources, and whether the higher salinity of the tube well, would have any effect, on the growth and yield of the crops to be tried. It is, however, to be emphasized that such studies would have to be of a sufficiently long duration to understand to what extent salts would accumulate in the soil, taking into account the leaching normally taking place due to rains and, at what steps of salt accumulation crop growth might be impaired.

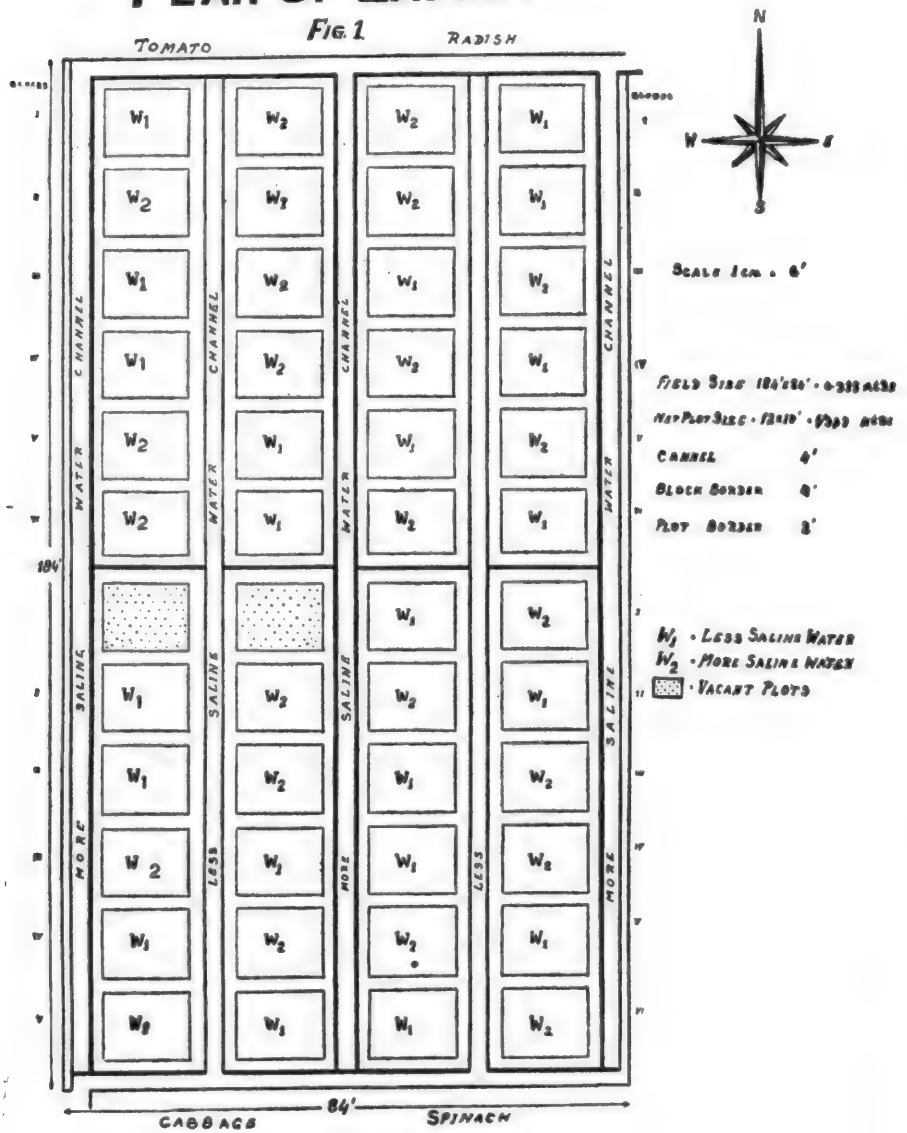
In the winter season of 1956—57, a field trial was conducted, to compare the performance of four vegetable crops, under irrigation, from surface well (salt content 845 ppm) and deep well (1430 ppm). The results of this trial have been presented and discussed in this paper.

Experimental procedure :

The experiment was laid out in a randomized block design. It comprised of four crop blocks, each having two different water treatments and six replications (in cabbage only five replications). The individual crop block was treated as a separate experimental unit. The details of layout and randomizations are given in Fig. 1.

PLAN OF LAYOUT

FIG. 1

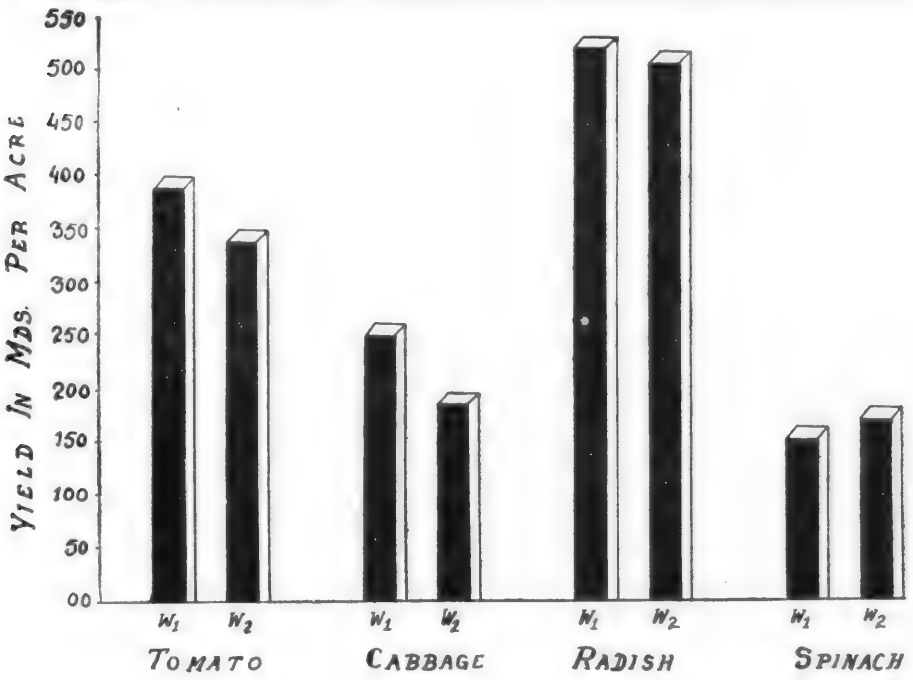


Tomato and cabbage seedlings were transplanted in the evening of 22nd October, 1956. Distance between lines was 2½ ft. and distance within the rows was maintained at 2 ft. Next morning all these plots were irrigated with their respective water treatments.

The sowing of radish and spinach was done on 23rd October, 1956. Spinach seeds were broadcast at the rate of 4 seers per acre and mixed in soil, with hand. Radish seeds were sown by dibbling, three seeds in each hole on ridges, at a distance of 1½ ft. × 6 inches.

Post sowing Operations :

S. No.	Name of Crop	Irrigation	Weeding and hoeing.
1.	Tomato	7	3
2.	Cabbage	5	3
3.	Radish	3	2
4.	Spinach	6	3



COMPARATIVE EFFECT OF WATERS OF VARYING SALT CONTENT ON THE YIELD PER ACRE OF FOUR VEGETABLES

Method of Irrigation :

Two types of irrigation, water, having salt contents of 845 ppm. and 1430 ppm. were used from a surface and tube well respectively. Separate channels were used for the two waters as shown in the layout (Fig. I).

Results and discussion :

The data on yield and the contributory plant characters are presented cropwise.

Tomato :

TABLE I

Mean yield of fruits in mds. per acre, yield in srs. per plant and stand of crop at harvest.

Water quality	Yields per acre (Mds.)	Yields per plant (Srs.)	Number of plants per acre.
Less Saline (W_1)	383.73	2·13	6,239
More Saline (W_2)	338·06	1·95	4,838
			Significant
		C. D. at 5 %	1,237.8

Though the yields per plant and per acre under tube well irrigation were less than those under surface well (W_1) irrigation, the differences were not significant. But there was a significant difference in the final stand.

Inspite of the same number of transplants in both the cases, the number of surviving plants was less in plots of more saline (W_2) water than those of W_1. This was due to higher mortality under the former condition.

Inspite of a significant reduction in stand under W_2 , the yields per plant and per acre were not reduced significantly. It is possible that the handling of the sample plants for growth measurement during the life cycle (12 readings) might have had an adverse effect on the yield of these plants. Such a difference in yields might have not occurred between W_2 and W_1 in the non-sampled plants of the plots.

Cabbage :

TABLE II

Average yield of heads in mds. per acre, per plant yield in srs. and stand of the crop at harvest.

Water quality	Yield per acre (mds.)	Yield per plant (srs.)	Number of plants per acre.
Less Saline (W_1)	247.29	1.51	4,659
More Saline (W_2)	182.86	1.81	3,146

The stand per acre and the yield per acre under W_2 were less than those under W_1, while per plant yield was more under W_2 than that of W_1 plots, but these differences were not significant.

As in tomato, though an equal number of seedlings was transplanted in cabbage the survival was less in W_2 plots. The slightly greater per plant yield under W_2 might have been caused by the beneficial effect of less competition between the plants. Tomato did not show this effect under a similar situation, probably because of the spreading and climbing nature of the plants.

Radish :

TABLE III

Average yield of Radish (whole plant) in mds./acre, per plant yield and stand of the crop at harvest.

Water quality	Yield per acre in mds.	Fresh weight per plant in gms.	Number of plants per acre.
Less Saline (W_1)	518.72	373.7	59,080
More Saline (W_2)	502.39	334.7	59,080

Though the yield per acre and individual plant yield were less under W_2 than under W_1, the differences were not significant. There were equal number of plants under both the treatments.

Spinach :

TABLE IV

Average yield of spinach, in mds. per acre, crop stand per sq. ft., No. of leaves per plant and length and width of leaves.

Water Quality	Yield per acre (Green leaves) in mds.	Stand per sq. ft.	No. of leaves per plant	Length of leaf	Width of leaf
Less saline (W_1)	150.23	16.1	18.7	14.98	5.1
More saline (W_2)	177.96	14.2	17.9	17.20	5.7

Though the yield of green leaves was more under W_2 than in W_1 plots, the difference was statistically non-significant. The stand was less in W_2 than in W_1 . It appears that the slightly higher yield under W_2 (non-significant) was caused by bigger sized leaves under W_2 .

From the results discussed above it is clear that the Tomato and Cabbage yields were slightly lower under W_1 than under W_2 . Radish crop showed no difference in yield due to the types of water, whereas spinach crop showed better yield under the more saline water. Better yield of spinach under more saline conditions seems to have been brought about by increased value of growth attributes of the crop. Similarly reduced values for the yield of Tomato and Cabbage under W_2 might have been due to less per plant yield in both the cases and a significant difference in crop density under Tomato.

Accumulation of Salts in the soil due to Irrigation from waters of differing salinity :

Soil samples were taken from the plots under the different crops after the harvest and the Electrical conductivity of the saturation extract was determined to assess the salt content. The data are presented in App. table I. The Radish crop received only three irrigations and it is seen that no appreciable change resulted in the salt content of soil in the radish plots as a result of these irrigations and also the effect of the more saline irrigations as compared with the less saline, was negligible. Tomato and Cabbage received higher number of irrigations i.e. 5–7, and the conductivity measurements reveal evidence of salt accumulation in these plots. However, in Tomato and in Cabbage the salt accumulation was seen to be very much more than that under spinach.

Conclusion :

The yield data as also the measurements of growth in the different crops, discussed above, have brought to light that spinach did better under the more saline water than the other crops. The reduced salt accumulation in spinach plots as also its better performance under the more saline irrigation may be indicative of the fact that spinach is more salt tolerant than the other crops.

APPENDIX TABLE I

Electrical conductivity millimhos/cm., at 25°C of saturation soil extract in the plots after crop season.

S. No.	Name of Crop	No. of irriga-tions	Plots treated with different qualities of water	E.*C.	Soluble salt content in ppm
1.	Soil sample before sowing.			3.40	2210.0
2.	Tomato	7	W_1	4.90	3185.0
			W_2	5.20	3380.0
3.	Cabbage	5	W_1	4.50	2925.0
			W_2	5.15	3347.5
4.	Radish	3	W_1	3.00	1950.0
			W_2	3.30	2135.0
5.	Spinach	6	W_1	3.60	2340.0
			W_2	4.25	2762.5

* Electrical conductivity in millimhos/cm. at 25°C.

INFLUENCE OF TIME OF SEPARATION ON ROOTING AND ESTABLISHMENT OF AIR-LAYERS IN THREE VARIETIES OF MANGO (*Mangifera indica* Linn.)

S. P. S. Chauhan and S. M. Singh

The established method of vegetative propagation of mango consists in inarching, which is tedious and expensive, and hence needs modifications or may be replaced altogether by another cheap and easy method of propagation. Air-layering has been suggested as an improvement on the conventional method of inarching (2, 5), since it holds promise for quick and cheap propagation. Moreover, even when the mango is propagated by inarching or budding, its root-stock has to be standardized. In the absence of polyembryony in the commercial varieties of north India and failure of the cuttings to strike roots, standardized and uniform root-stocks can be raised only by layering.

Mango varieties show marked variations in the rooting of their air-layers (2, 3, 4, 5), and hence it is necessary to explore all possibilities of improvement in the results with different varieties. Early rains have been found to be the best time for the layering operation (1, 5), but no information is available on the period for which the air-layers should be allowed to remain attached with the mother plants for success in rooting of layers as well as their establishment after separation, though most of the workers have separated the layers about 2 to 2½ months after operation. This paper describes the results of an experiment on the effect of time of separation on the performance of air-layers of three varieties of mango.

Materials and Methods :

The treatments of this investigation included three varieties, viz., Bombay green, Fazri zafrani and Langra, and four dates of separation, viz., 7, 9, 11 and 13 weeks after layering. This gave 12 treatment combinations which were replicated four times, the design of the experiment being randomised block. One bearing tree of about 20 years age was selected from each variety and four scaffold branches on each tree were taken for the four blocks and a group of ten layers on these branches formed a plot.

On July 15, 1960, two year old branches were selected for the layering operation which consisted in the removal of 4 cm. long ring of bark along with the cambium, over which a ball of gootee soil consisting of clay soil and leaf-mould in equal proportion was placed and then wrapped with a 500 gauge 9″ × 9″ polythene piece, which was tied firmly at both the ends.

The layers were separated from the mother plants on the due dates according to the plan of layout. After taking necessary observations the rooted layers were planted in pots for studying their establishment for two months after separation.

Results :

Though the survival of layers at separation did not differ much in the three varieties, the differences in respect of other characters were very marked (Table I). Langra was not only the poorest in rooting (26·8%) and establishment (11·5%), but the number and length of roots were also very poor in this variety. In rooting and development of roots Bombay green was very close to Fazri zafrani, but in the establishment of the rooted layers, the latter was far superior to the former. The superiority of Fazri zafrani over Bombay green in the performance of its layers was thus obvious.

TABLE I

Survival, rooting and establishment of layers and development of roots in the three varieties.

Variety	Per cent alive	Per cent rooted	Per cent established	Number of roots per rooted layer	Length of the longest root per layer in mm.
Bombay green	76·9	48·7	26·9	8·1	63·7
Fazri zafrani	68·8	51·8	46·7	8·7	70·9
Langra	67·8	26·8	11·5	3·7	47·3
C. D. at 5%	Not	9·60	17·24	—	—
C. D. at 1%	significant	12·59	22·66	—	—

When the layers were separated at 7 weeks after operation, only 15·8 percent had rooted (Table II). Though the number of roots per rooted layer in this case was as good as in the later dates, these were much shorter and hence they failed to nourish the layers properly after separation with the result that even the rooted ones died soon after planting in pots. By delaying the separation to 9 weeks after operation the rooting percentage as well as the length of roots improved markedly, but still only 8·3 percent of the rooted layers were able to establish as new plants. When the separation was done at 11 weeks after operation, the establishment percentage increassed to 51·4. Beyond this there was only slight improvement in the performance of the layers. As expected, the survival percentage did not differ significantly in the different dates of separation.

TABLE II

Effect of time of separation on survival, rooting and establishment of layers and development of roots.

Time of separation (weeks after operation)	Per cent alive	Per cent rooted	Per cent established	Number of roots per rooted layer	Length of the longest root per layer in mm.
7	65·8	15·8	0	7·4	33·2
9	80·8	50·0	8·3	7·6	64·8
11	72·5	51·6	51·4	6·9	71·1
13	65·0	52·5	53·6	5·5	73·0
C. D. at 5%	Not	10·98	19·78	—	—
C. D. at 1%	significant	14·39	26·01	—	—

The superiority of Fazri zafrani over the other two varieties became more clear by studying the establishment of the rooted layers of the three varieties separated on the different dates (Table III). None of the layers established as new plant in the first date of separation, but in the case of 9 weeks 25 per cent of the rooted layers of Fazri zafrani were able to establish, whereas in the other two varieties all of them died soon after planting. Another interesting point about the comparative performance of the layers of the three varieties was

that in Fazri zafrani the percentage of establishment improved upto the last date of separation and as high as 95 percent of the layers resulted in new plants but in the other two varieties there was no further improvement beyond 11 weeks.

TABLE III

Effect of time of separation on percentage establishment of the layers in the three varieties.

Variety	Time of separation in weeks after operation			
	7	9	11	13
Bombay green	0	0	54·2	53·4
Fazri zafrani	0	25·0	66·7	95·0
Langra	0	0	33·3	12·5

Discussion :

The three varieties tried in this experiment showed marked variations in the performance of their air-layers. Langra not only gave the lowest percentage of rooting but the number and length of roots were also the poorest in this variety, which resulted in very low percentage of establishment of its rooted layers. Fazri zafrani gave the best results and Bombay green was next to it. Marked varietal differences in the performance of mango air-layers have also been reported by a number of other workers (2, 3, 4, 5), and Langra was found to give very poor results in all the experiments where it was included. Singh (4) thought that rooting response of mango varieties was in some way related to their vigour. The establishment of the rooted layers after separation appeared to be governed by the extent of root growth in the layers at separation.

This experiment has given very interesting results regarding the period for which the air-layers should remain attached with the mother plants, on which aspect almost no information is available in the literature. 7 weeks was not only insufficient for rooting but the rooted layers separated at this stage died soon after planting. 9 weeks gave satisfactory rooting, but in this case also the establishment of layers was exteremely poor. When the layers were separated 11 weeks after operation, rooting as well as establishment were quite satisfactory but the time of separation appeared to be governed by some varietal factors since in Fazri zafrani the best results were obtained when the separation was done

13 weeks after operation. In the case of earlier separation the roots were shorter and brittle and they failed to support properly the rooted layers after planting. These findings have thus shown that mango air-layers should not be separated from the mother plants before 11 week and in varieties like Fazri zafrani they should remain attached with the mother plants for still longer periods.

Summary :

An experiment investigating the response of air-layers of three varieties of mango to four dates of separation is described. Langra which is among the most important varieties of north India, was found not only very shy to root from air-layering (26·8 percent rooting), but even its rooted layers were very poor in establishing as new plants (11.5 percent establishment). Fazri zafrani gave the best results in all respects (51·8 percent rooting and 46·7 per cent establishment), but Bombay green was also close to it except in establishment which was poor in this variety.

Separation of the layers from mother plants at 7 weeks after operation was not only insufficient for proper rooting but even the rooted layers failed to establish as new plants if separated at this stage. Attachment of air-layers with the mother plants for 9 weeks gave satisfactory rooting but the establishment was poor in this case also. 11 weeks after operation appeared to be an overall optimum period because beyond this there was not much improvement in the performance of the layers. This factor, however, appears to be governed by varietal characteristics and in Fazri zafrani the air-layers may usefully remain attached with the mother plants for 13 weeks.

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INFLUENCE OF TIME OF OPERATION AND CONCENTRATION OF INDOLE—3—BUTYRIC ACID ON BUDDING OF GRAPEFRUIT (*CITRUS PARADISI* MACF.) ON KHATTA (*CITRUS KARNA* RAF.) ROOTSTOCKS.

R. C. Gupta, R. G. Maiti and S. M. Singh.

The common method of vegetative propagation in grapefruit is shield budding. Nurserymen usually bud their citrus stock either during September-October when rains are over and winter has not yet set in or during March-April when winter is over but hot winds have not started blowing (7). Under north Indian conditions Bhadauria *et al* (1) and Singh (7) obtained higher success by budding the plants in June, while Hayes (3) recommended mid winter and early rain for this purpose.

Some of the plant regulators have been found to improve the success in graftage (2) Maiti *et al* (5) preferred indole—3—butyric acid (IBA) over indoleacetic acid (IAA) in budding grapefruit on khatta rootstocks.

The present paper describes the results of an experiment carried out to find out the influence of season of budding and concentrations of IBA on budding of grape fruit.

Methods and Materials:

One year old khatta seedlings were planted at 1' spacing each way in the nursery on August 13, 1959 for rootstocks according to the randomised block layout with four replications. They were budded on Feb. 22 and 23, and June 22 and 23, 1960. Before insertion into the matrix, buds were treated with five concentrations of IBA (0, 500, 750, 1000, and 1250 ppm) prepared in 50 per cent alcohol by quick-dip method. Thus there were 10 treatment combinations (2 times of operation × 5 concentrations of IBA) and a row of 10 plants formed a plot. A border of one row of plants around each block was also given.

The scion buds were taken from healthy, round and less thorny shoots of about one year old. Bud shields without wood which were found to be better than buds with wood (5 & 6) were used in this experiment. Any bud noticed to have received even a slight injury was discarded.

Results :

The number of buds that were alive at the time of final observation 8 weeks after buddings, was expressed in terms of percentage of the total number of plants budded under each treatment to find out the percentage of bud-take in that treatment, while for calculating the percentage of success only those buds that were growing were considered.

Time of operation had a profound effect on both the above characters. When the operation was done in February, bud-take and success were 35·0 per cent and 30·5 per cent respectively, whereas these results increased to almost one and a half times when the budding operation was delayed upto June (Table I). The diameter of scion shoot was also more in case of June budding.

TABLE I

Effect of time of operation on bud-take, success and diameter of scion shoot.

Time of operation	Per cent bud-take	Per cent success	Diameter of scion shoot in mm.
February	35·0	30·5	3·70
June	47·5	45·5	4·56
C. D. at 1%	8·73	9·19	0·52

The concentrations of IBA produced marked effect on bud-take and success. Statistically 500 ppm was as good as control, but further increase in concentration upto 1000 ppm brought significant improvement in the results. However, concentration beyond 1000 ppm produced very much depressing effect; thus the results obtained with 1250 ppm were inferior even to the control (Table II). The diameter of the scion shoot was not statistically affected by these concentrations.

TABLE II.

Effect of concentrations of IBA on bud-take, success and diameter of the scion shoot.

Concentration of IBA	Per cent bud-take	Per cent success	Diameter of scion shoot in mm.
0 ppm	35·0	28·75	3·90
500 ppm	35·0	31·25	3·92
750 ppm	50·0	47·50	4·12
1000 ppm	62·50	61·25	4·40
1250 ppm	23·70	21·25	4·30
C.D. at 5%	10·20	10·47	Not
C.D. at 1%	13·90	14·55	significant

The highest percentage of success (70·0) was obtained when the budding operation was done in June treating the scion buds with 1000 ppm of IBA, while in February budding the highest success was only 52·5 per cent but this also was obtained under the same concentration. In both these cases, however, the success was more than double as compared to control (Table III) .

TABLE III.

Percentage of success under various treatments.

Time of operation / Concentration of IBA	February budding	June budding
0 ppm	25·0	32·5
500 ppm	27·5	35·0
750 ppm	35·0	60·0
1000 ppm	52·5	70·0
1250 ppm	12·5	30·0

Interaction not significant.

Discussion :

Budding may be successful when the cells of the cambium layer are actively dividing, which is indicated by the ready separation of the bark from the wood (4). Such a condition is available in north India over quite a long period. Thus under these conditions the important consideration is the post-budding weather. The temperature and humidity of the atmosphere should be comparatively high to allow the buds to unite readily and grow properly. In this part such favourable conditions are best observed about the later part of June, when the temperature is favourably high and the atmosphere becomes rich in humidity because of monsoon winds. In the present experiment higher success and thicker budeings were, therefore, obtained by budding the plants in June in comparison to February. Superiority of budding in June has also been reported by Singh (7) at Saharanpur and Bhadauria *et al* (1) at Agra.

Not much information is available on the application of plant regulators on budding of citrus. Dragus and Avramov (2) treated the vine grafts with different plant regulators and found IAA most satisfactory for healthy callus formation resulting in good graft union. While working on citrus budding Maiti *et al* (5) reported the superority of IBA over IAA. They obtained the best results with 1000 ppm and also noted the detrimental effect of the concentration higher than this.

The results of the present experiment have confirmed the superiority of 1000 ppm of IBA over other concentrations for achieving higher success in budding of grapefruit on khatta rootstock. Concentration higher than this markedly reduced the success possibly due to some injury to the plant tissues. The beneficial effects of proper concentration of IBA in grapefruit budding, is therefore, evident.

Summary :

An investigation conducted during 1959-60 to study the influence of time of operation (February and June) and concentration of Indole—3—butyric acid (0,500, 750, 1000 and 1250 ppm) in 50 per cent alcohol applied by quick-dip method on budding of grapefruit (**Citrus paradisi** Macf.) on khatta (**Citrus karna** Raf.) rootstock is described.

The bud-take and success were 35·0 per cent and 30·5 percent respectively when the operation was done in February; while one and a half times increase in the above results was obtained by budding the plants in June.

The results were greatly influenced by the different concentrations of IBA. 35·0 per cent bud-take and 28·75 per cent success were obtained under control which was as good as 500 ppm but further increase in concentration brought significant increase in results upto 1000 ppm when both bud-take and success were almost double in comparison to the control. However, concentration beyond 1000 ppm brought a sharp decline in the results.

The maximum success of 70 per cent was obtained in June budding by treating the scion buds with 1000 ppm IBA.

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STUDIES ON BLOOD

I. BLOOD NORMS OF INDIAN BUFFALOES—*Bos bubalis L.*

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Introduction :

Of the several aspects, the study of blood has been occupying a prominent place in the nutritional and physiological researches. The significance of such studies on domestic animals has been emphasised by several workers (Kehar et al., 1940 ; Mullick and Pal, 1943 ; Kehar and Murti, 1945 and Hathoot et al., 1956) as an aid in diagnosing the various pathological and metabolic disorders. Not only this but the normal haematological values are known to be of great significance in investigating the origin and evolutionary trends of species and breeds. Some workers have also claimed that the level of certain blood constituents may be used as a guide in evaluating the adaptability of animal to certain environments and high haemoglobin values are indicative of the adaptability of animal to tropical countries. The nutritional deficiencies are also known to be reflected in the blood picture long before the development of the clinical symptoms. The study of blood constants and constituents has thus shown a good deal of correlation between the nutritional status and the haematological standards of animals. Such being the significance of blood studies it was considered worthwhile to extend these studies to buffalo which has now come to play a very significant role in Tropical Dairying and is rapidly pushing out the cow from the position it has been enjoying since indefinite period.

Review of Literature :

Normal blood values for dairy cattle have been published by Anderson et al. (1930) ; McCay (1931) ; Ferguson (1937); Delaine (1940); Duke (1942) Mullick and Pal (1943) ; Pal & Mullick (1945) ; Singh (1942 & 1945) ; Sen (1946) ; Rusoff & Piercy (1946) ; Rusoff (1951) ; Rusoff, Johnston & Branton (1954); Thomas Jackson & Moor (1954) ; Greatorex (1957) and Schieltze (1957). In general there is voluminous literature on blood studies of dairy cow. The effect of such factors as breed, age, feed, stage of lactation and gestation, season and environmental temperature has been investigated with reference to the normal values of various blood constants and constituents. Parallel information on

buffalo is rather meagre. A perusal of the available literature shows that no systematic work on its blood has so far been attempted.

Sankaranarayanan (1947) was probably the first to study cow and buffalo both for establishing the haematological standards, and found that the indigenous breeds such as Gir and Sindhi have higher values of red and white blood corpuscles than those of the foreign breeds and the cross breds and buffalo had the highest figures. It was, however, indicated that the proportion of different forms of leucocytes was nearly the same for both cow and buffalo. He has further suggested that the phosphate feeding affects the structural changes in the blood of these animals.

Kehar and Murty (1945) have studied the haematological constituents of Hariana bullocks fed on protein deficient diet and reported that R.B.C., W.B.C. cell volume, haemoglobin, lymphocytes and neutrophils were decreased, while the monocytes and the eosinophils increased. They have further established the various haematological constants for Kumaon bullocks and compared them with those of buffalo and Hariana and Dhani bullocks (1951). Atree (1956) has also studied the haematological constants for buffalo kept on protein deficient diet and concluded that 40% level of urea substitution resulted in a significant increase in the cell volume and the W.B.C. counts.

Methods and Materials :

The observations reported herein are based on 38 normal animals of Murrah breed of buffalo including both males and females of different ages. These were maintained on the College Dairy Farm under reasonably good management and adequate feeding throughout the experimental period. The collection was replicated twice with an interval of one month. The animals in each group were almost of similar age and body weight and were distributed as under:—

Young			
	Male	Below 1 year	4
		Between 1 & 2 years	4
	Female	Below 1 year	4
		Between 1 & 2 years	4
Adult			
	Male	Bullocks	8
		Breeding bulls	2
	Famale	Lactating non-pregnant	4
		Lactating pregnant	4
		Dry pregnant	4
		Total.	38

All the tests were conducted on the venous blood collected from the jugular vein during the early morning hours. The sample (about 20 c.c.) was collected using standard method (Napier and Das Gupta, 1946) in a 50 c.c. glass stoppered wide—mouth bottle containing oxalate powder as the anticogulant. The unoxalated blood was used for smearing the slides for differential count. Immediately after collection the blood was transferred to the laboratory and stored in refrigerator at 5°C till used for analysis. The time limits recommended by Osgood and others (1931) for different examinations were followed and the following physical constants were determined by the methods described by Napier and Das Gupta (1946). The tests conducted were as under :—

1. Haemoglobin Content.
2. Cell volume.
3. Erythrocytic (R.B.C.) Count.
4. Leucocytic (W.B.C.) Count.
5. Differential Count expressed as percentage of :—
   (a) Lymphocyte
   (b) Neutrophil
   (c) Eosinophil
   (d) Monocyte
   (e) Basophil.
6. Corpuscular values (by calculation)
   (a) Mean Corpuscular Haemoglobin (M.C.H.)
   (b) Mean Corpuscular Volume (M.C.V.)
   (c) Mean Corpuscular Haemoglobin Concentration. (M.C.H.C.)

For the differential count the smears were stained with Romanowsky stains and examined at leisure. Of the various stains tried, namely, Leishman (0·15%), Wright (0·15%) and Jenner (0·05%), Leishman gave the best results. The identification of the different cell types was based on the granular cytoplasmic inclusions and their kind as below:—

Neutrophilic : small, numerous, uniformly sized with dull lilac shade,

Eosinophilic : large, round, uniformly sized and staining orange red with pale centres.

Basophilic : super-imposed, un-uniformally sized and taking a dark blue violet colour different from the nucleus.

Monocytes & Lymphocytes : Not containing any granule except some stained particles, the so called azurophil granules and consequently visible as light blue bodies. The azurophilic particles, being fewer and larger in lymhocytes than in the monocytes in which they are numerous but smaller and more evenly distributed within the cytoplasm.

Experimental Findings :

The results obtained during the course of this investigation have been statistically treated and tabulated. Attempts have also been made to find out suitable explanation for the results obtained and to compare with the previous work, wherever available.

Haemoglobin and Cell Volume :

The average values for hæmoglobin and cell volume have been presented in Table I.

Both haemoglobin and cell volume show almost a similar trend. Their values are higher for growing animals than the adults. It, therefore, suggests that the haemoglobin and cell volume decrease with age. However, the values for the breeding bulls are exceptionally high, most probably due to their flushing and young age. This pulls the total value of haemoglobin for the adults slightly higher than that for the young, which is a deviation from the general trend. The difference due to sex appears to be insignificant. However, the cell volume in case of adult males is significantly higher than in adult females, but amongst the young animals this difference is insignificant.

Among the adult females the lactating non-pregnants and dry pregnants do not differ significantly while the lactating pregnants have higher values than the above groups.

Thus both, haemoglobin and cell volume show almost a similar trend. The averages for the female calves (below one year) closely agree with those reported by Mullick and Pal (1943). However, our values for adult males do not agree with those reported by Kehar and Murty (1951).

Cell Counts :

The average values of cell counts for different groups have been detailed in Table II.

Like the hæmoglobin and the cell volume, the R.B.C. counts are also higher in the young animals and decline with age. The average values are slightly higher for the males (both adult and young) than for the corresponding

TABLE I

Showing the Average Hæmoglobin and Cell Volume values of Indian Buffaloes.

GROUPS	No. of Animals	Haemoglobin (gm. / 100 cc. of blood)	Cell Volume (percent)
YOUNG			
Female			
(a) Below 1 year	4	13·125 ± 0·270	38·000 ± 2·500
(b) Between 1 & 2 years	4	14·000 ± 0·220	40·250 ± 1·310
Average	8	13·562 ± 0·430	39·125 ± 1·301
Male			
(a) Below 1 year	4	13·875 ± 0·375	42·000 ± 1·600
(b) Between 1 & 2 years	4	13·125 ± 0·380	36·500 ± 0·640
Average	8	13·500 ± 0·280	39·250 ± 1·301
Total YOUNG Average	16	13·531 ± 0·251	39·187 ± 0·920
ADULT			
Female			
(a) Lactating Non-pregnant	4	12·625 ± 0·240	34·375 ± 2·075
(b) Lactating pregnant	4	14·000 ± 0·200	38·500 ± 1·060
(c) Dry pregnant	4	12·000 ± 0·830	35·000 ± 2·300
Average	12	12·875 ± 1·361	35·958 ± 0·680
Male			
(a) Bullocks	8	13·125 ± 1·100	37·781 ± 0·810
(b) Breeding bulls	2	16·875 ± 0·375	47·000 ± 2·500
Average	10	15·000 ± 0·581	42·390 ± 1·313
Total ADULT Average	22	13·937 ± 0·739	39·174 ± 0·739

TABLE II

Showing the average Blood Cell Counts of Indian Buffaloes.

GROUPS	No. of Animals.	R. B. C. (millions/cu mm.)	W. B. C. (Thousands/cu mm.)
I. YOUNG			
1. Female			
(a) Below 1 year	4	9·245 ± 0·750	13·945 ± 1·410
(b) Between 1 & 2 yrs.	4	10·145 ± 0·345	20·225 ± 1·810
Average	8	9·695 ± 0·412	17·085 ± 1·101
2. Male			
(a) Below 1 year	4	10·692 ± 0·396	12·070 ± 0·260
(b) Between 1 & 2 yrs.	4	9·325 ± 0·540	11·474 ± 0·840
Average	8	10·008 ± 0·402	11·770 ± 1·010
Total YOUNG Average	16	9·848 ± 0·237	14·470 ± 0·745
II. ADULT			
1. Female			
(a) Lactating non-pregnant	4	6·715 ± 0·548	9·786 ± 2·311
(b) Lactating pregnant	4	7·740 ± 0·425	10·400 ± 1·410
(c) Dry pregnant	4	6·582 ± 0·270	12·910 ± 1·150
Average	12	7·012 ± 0·441	11·032 ± 0 930
2. Male			
(a) Buflocks	8	7·647 ± 0·280	8·462 ± 0·280
(b) Breeding Bulls	2	9·775 ± 0·595	8·055 ± 1·335
Average	10	8·711 ± 0·328	8 258 ± 0·682
Total ADULT Average	22	7·861 ± 0·274	9·679 ± 0·576

TABLE III

Showing the average Corpuscular values for Indian Buffaloes.

GROUPS	No. of animals	M. C. H. (micro-micro gm.)	M. C. V. (Cubic-microns.)	M. C. H. C. (percent)
I. YOUNG				
1. Female				
(a) Below 1 year	4	14·322 ± 0·470	41·246 ± 1·310	34·675 ± 0·890
(b) Between 1 & 2 years	4	13·890 ± 0·680	39 945 ± 2·290	34·849 ± 0·650
Average	8	14·110 ± 0·390	40·596 ± 1·100	34·762 ± 0·512
2. Male				
(a) Below 1 year	4	12·998 ± 0·250	39·293 ± 0·400	33·075 ± 0·440
(b) Between 1 & 2 years	4	14·360 ± 1·230	39·423 ± 1·610	36·033 ± 1·620
Average	8	13·679 ± 0·640	39·358 ± 0·760	34·554 ± 1.300
Total YOUNG Average	16	13·895 ± 0·374	39·977 ± 0·668	34·658 ± 0·698

II. ADULT				
1. Female				
(a) Lactating non-pregnant	4	19·436 ± 1·590	52·332 ± 3·260	37·081 ± 1·830
(b) Lactating pregnant	4	18·280 ± 0·810	50·378 ± 3·070	36·418 ± 0 890
(c) Dry pregnant	4	18·280 ± 0·730	53·400 ± 2·740	34·330 ± 1·070
Average	12	18·655 ± 1·030	52·036 ± 1·470	35·943 ± 1·600
2. Male				
(a) Bullocks	8	17·483 ± 0·960	50·223 ± 2·300	34·798 ± 0·100
(b) Bredding Bulls	2	17·302 ± 0·670	48·100 ± 0·370	35·960 ± 1·120
Average	10	17·392 ± 0·585	49·161 ± 1·165	35·379 ± 0·563
Total ADULT Average	22	18·044 ± 0·592	50·776 ± 0·938	35·568 ± 0·848

females, though the difference is insignificant. The values for lactating non-pregnant and dry pregnant groups are almost similar. But for the lactating pregnants it is insignificantly higher.

The W.B.C. counts, on the other hand, show a slightly different trend than the R.B.C. It is noted that the females in general, both young and adults, have higher W.B.C. counts than the males. When the comparison is made within the sex of different age groups, the values are significantly higher for the growing animals than the adults. In adult females of different groups, viz., lactating non-pregnants ; lactating pregnants and dry pregnants, the average differences are only slight and insignificant. The value for the dry pregnant is little higher than those for the lactating non-pregnants and the lactating pregnants. Values for the adult animals, in general, come out to be lower than those recorded by Sankaranarayanan (1937) for buffaloes.

Corpuscular Values :

The average corpuscular values M.C.H., M.C.V., and M.C.H.C. arrived at by calculation have been assembled in table III, alongwith their standard errors.

A close perusal of the table indicates an almost similar trend of all the three constants in different groups. The values are significantly higher for the adult animals than for the young irrespective of the sex. For the different categories of females the values are almost similar which suggests that pregnancy and lactation have no significant effect on them. Age, therefore, seems to be the only influencing factor on these values.

The average values of M C.H. for adults are slightly higher than those reported by Kehar and Murty (1951) for male buffaloes. The values for the females in general are slightly higher than those for the males, but this difference is negligible.

The average values for the M.C.V. on the other hand for both adults and young compare low with those of Kehar and Murty (1951) for male buffaloes. The values for the young on the other hand compare favourably with those of Pal and Mullick (1945) for the dairy cattle. Like M.C.H., M.C.V. also presents slightly higher values for the females than for the males and again the difference is small and insignificant.

The values for M.C.H.C. are significantly higher than those of Kehar and Murty (1951) for male buffaloes, and of Mullick and Pal (1943) for the dairy cattle.

White Cell Differential Count :

The values for the different W.B.C. counts, namely lymphocytes, neutrophils, eosinophils, monocytes, and basophils have been presented in Table IV.

A critical examination of the above data indicates that the lymphocytes are the largest in number and are followed by neutrophils, eosinophils, monocytes and basophils in succession. Of all the white cell types eosinophils vary most widely both within and between groups. The number of eosinophils, neutrophils and basophils increases with age while that of the lymphocytes and monocytes show a reverse trend. However, the lactating females have more lymphocytes and less eosinophils than the non-lactating ones. This partly supports the statement of Greatorex (1957), which holds that the lymphocytes and the eosinophils get fewer while the neutrophils increase during the "drying off" process in the females. The basophils, in general, are negligible and hard to be demonstrated in many of the cases.

So far as the differences in the lymphocytic values between the sexes of the different age groups are concerned, the males have higher values than the females in young animals while the reverse is true for the adults.

On comparing the neutrophilic values of different groups, we find that it is only the adult males which differ significantly from the young ones. The different age groups of males and females on the other hand differ such that the adult males have higher values than the females while the young ones show a reverse trend. It is just opposite to what has been observed in case of lymphocytes.

The eosinophilic values seem to be considerably affected by age. The adult and young groups, therefore, do not differ much within them with regard to sex but they do differ significantly between themselves.

The sub-groups of the adult females do not show a significant variation in respect of eosinophils, but their number is slightly higher in case of dry buffaloes. This fact, however, contradicts the findings of Greatorex (1957) as already stated.

From what has been said above it appears that probably monocytes are the least variable and do not seem to be influenced much by age, sex, pregnancy and lactation whichsoever. Our values for monocytes are supported by the observation of Sankaranarayanan (1937).

The values for basophils are negligible and the variation amongst the adult males and females seem to be quite pronounced. Our findings contradict the statement of Sankaranarayanan (1937) that the basophils are found to be absent in healthy animals.

For convenience the average values for various morphological constants for young and adult of the two sexes, as recorded during this investigation are summarised in Table V.

TABLE IV

Showing the W. B. C. differential count for Indian Buffaloes.

GROUPS	No. of animals	Lympho-cytes (percent)	Neutro-phils (percent)	Eosino-phils (percent)	Mono-cytes (percent)	Baso-phils (percent)
I. YOUNG						
1. Female						
(a) Below 1 year	4	67·27 ± 3·45	21·61 ± 1·40	5·58 ± 1·86	5·38 ± 0·54	0·18 ± 0 17
(b) Between 1 & 2 years	4	64·88 ± 4·09	20·80 ± 2·80	7·53 ± 1·88	6·80 ± 0·55	—
Average	8	66·07 ± 2·10	21·20 ± 1·45	6·55 ± 1·30	6·09 ± 0·45	0·09 ± 0·03
2. Male						
(a) Below 1 year	4	69·43 ± 0·54	16·98 ± 0·51	7·03 ± 0·73	6·58 ± 0·37	—
(b) Between 1 & 2 years	4	67·43 ± 2·26	22·78 ± 1·40	3·58 ± 0·56	6·23 ± 0·56	—
Average	8	68·43 ± 1·07	19·88 ± 1·30	5·30 ± 0·78	6·40 ± 0·33	—
Total YOUNG Average	16	67·25 ± 1·18	20·54 ± 0·97	5·93 ± 0·76	6·24 ± 0·28	0·04 ± 0·02

II. ADULT

1. Female						
(a) Lactating Non-pregnant	4	65·05 ± 0·88	22·10 ± 0·60	7·11 ± 1·11	5·50 ± 0·34	0·25 ± 0·25
(b) Lactating pregnant	4	67·06 ± 1·83	19·52 ± 0·59	7·91 ± 1·09	5·26 ± 0·34	0·25 ± 0·25
(c) Dry pregnant	4	59·05 ± 3·35	23·85 ± 2·51	11·80 ± 1·97	5·33 ± 0·75	—
Average	12	63·81 ± 2·48	21·82 ± 1·40	8·94 ± 1·00	5·36 ± 0·20	0·17 ± 0·06
2. Male						
(a) Bullocks	8	58·84 ± 2·10	25·81 ± 0·70	9·00 ± 0·92	5·92 ± 1·08	0·42 ± 0·03
(b) Breeding bulls	2	54·70 ± 3·70	28·50 ± 2·00	10·10 ± 1·90	6·70 ± 0·20	—
Average	10	52·77 ± 2·13	27·15 ± 1·06	9·55 ± 1·06	6·31 ± 0·55	0·21 ± 0·02
Total ADULT Average	22	60·58 ± 1·63	24·27 ± 0·88	9·15 ± 0·72	5·77 ± 0·29	0·22 ± 0·01

TABLE V

Showing the Morphological Blood Constants of Indian Buffaloes.

Haematological Constant	YOUNG		ADULT	
	Female	Male	Female	Males*
Hb (gms. / 100 cc. of blood)	13·56 ± 0·43	13·50 ± 0·28	12·88 ± 1·36	13·13 ± 1·10
Cell Volume (%)	39·13 ± 1·30	39·25 ± 1·30	35·96 ± 0·68	37·78 ± 0·81
R.B.C. (millions / cu. mm. of blood)	9·70 ± 0·41	10·01 ± 0·40	7·01 ± 0·44	7·65 ± 0·28
W.B.C. (thousands/per cu.mm. of blood)	17·09 ± 1·10	11·77 ± 1·01	11·03 ± 0·93	8·46 ± 0·28
M.C.H. (micro-micro gm.)	14·11 ± 0·39	13·68 ± 0·64	18·67 ± 1·03	17·48 ± 0·96
M.C.V. (cubic microns)	40·60 ± 1·10	39·36 ± 0·76	52·04 ± 1·47	50·22 ± 2·30
M.C.H.C. (Percent)	34·76 ± 0·51	34·55 ± 1·30	35·94 ± 1·60	34·80 ± 0·10
Lymphocytes (%)	66·07 ± 2·10	68·43 ± 1·07	63·81 ± 2·48	58·84 ± 2·10
Neutrophils (%)	21·20 ± 1·45	19·88 ± 1·30	1·82 ± 1·40	25·81 ± 0·70
Eosinophils (%)	6·55 ± 1·30	5·30 ± 0·78	8·94 ± 1·00	9·00 ± 0·92
Monocytes (%)	6·09 ± 0·45	6·40 ± 0·33	5·36 ± 0·20	5·92 ± 1·08
Basophils (%)	0·09 ± 0·03	0·00 ± 0·00	0·17 ± 0·06	0·42 ± 0·03

* Bulls excluded for the reason of their very high values.

Summary and Conclusions :

The role of buffalo- *Bos* (*Bubalus*) *bubalis L.,* in tropical dairying has been emphasized and the paucity of systematic work on this animal has been pointed out. The importance of blood studies in the nutritional and physiological researches has been stressed and the leading approaches in that direction have been reviewed. The observations contained herein, are based on the haematological examination of 38 Murrah males and females of different age and functional groups.

The experimental animals were maintained on the College Dairy Farm under adequate feeding and management, and the samples were collected during early morning hours. The various hæmatological constants e.g. hæmoglobin, cell volume, R.B C. and W.B.C. counts, corpuscular values, and the differential counts were made by using standard methods. Some of the definite trends conceived from this investigation may be summarised as under :—

(1) The hæmoglobin, cell volume and cell counts (both R.B.C. and W.B.C.) in general are higher for the young and decrease with age. This decrease is maximum in the W.B.C. indicating that probably the resistance to diseases, infections and environments decreases with age. The maximum values have been noted for the young females followed by those for the growing males and adult females and the males.

(2) The corpuscular values on the other hand show a reverse trend and increase with age. This change being maximum in case of M.C.V. and minimum in case of M.C.H.C.

(3) Of the different white cell types, lymphocytes decrease while the neutrophils and the eosinophils increase with age. Monocytes and basophils on the other hand remain practically constant and do not vary much.

(4) With regard to sex, the males have slightly higher values than the females for hæmoglobin, cell volume and R.B.C. counts while the reverse is true for the W B.C. count and corpuscular values in general. Among the different white blood cells neutrophils and eosinophils are more in adult males and young females than their counter parts. The lymphocytes, however, show a reverse trend.

(5) The physiologically different adult female groups do not significantly differ from each other except for the hæmoglobin which is significantly higher in the lactating pregnant group than the rest. However, the values for the lactating pregnants are also higher than the lactating non-pregnants and dry pregnants for cell volume and R.B.C. counts. This seems to indicate that lactation and pregnancy if combined have higher requirement for hæmoglobin, cell volume and red blood cells.

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SURVEY OF BACTERIOLOGICAL QUALITY OF MILK IN AGRA CITY AND ITS SUBURBS

J. L. Ogra and Y. S. Rao

Milk which occupies a unique position amongst items of human dietary also constitutes a perfect medium for growth of micro-organisms. It is practically impossible to exclude micro-organisms from gaining entry into milk during its production and handling. The types and density of their population depends upon, sanitary conditions and management practices followed under different conditions of production. Bacteria that gain entry into milk multiply at a rapid rate in tropical countries where atmospheric temperature is favourable for their growth, and cause spoilage of milk, greatly reducing the keeping quality.

In India the dairy industry has not yet attained the status of a major industry. The producers i.e. farmers lack proper knowledge of sanitation, which results in the high bacterial count of milk. The very insanitary conditions of production and handling render it necessary to collect adequate data before recommendations for improving the conditions could be made and before bacterial standards formulated. The present investigation was taken up with this objective in mind.

Though quite a lot of work has been done in foreign countries on the bacteriological quality of milk precise information for our country is wanting very much. Evans (1916) and Breed (1928) reported that 93% of the total micro-organic population in freshly drawn milk is constituted of micro-cocci. That the coat of the animals and flies form the principal contamination sources for coli form group, yeasts, molds, spore formers and other pathogens has been shown by Evans (1916), Prucha et al (1918) Cronshaw (1947) and Hammer (1948). The main source through which lactic acid and thermoduric bacteria gain entrance into the milk is the untensil (Proctor 1943). Thomas & Selman (1951-55) investigated that most of the psuedomonas spp. are added to milk through water. In India too some investigations have been carried out on the microbial population of Indian milks. Verma (1944) and Laxminarayana (1946), surveyed the bacteriological quality of milk in Bangalore. Later on Verma

et al (1950) studied the spore formers in milk. Laxminarayana (1955) studied the distribution of micrococci in milk. Some information is also available from Lucknow, Allahabad and Agra but that does not consist of systematic studies.

EXPERIMENTAL

Samples were collected from the following sources:—

I Organised Dairies.

(i) Military Dairy Farm, Agra.
(ii) B. R. College Dairy Farm, Agra.
(iii) Dayalbagh Milk Co-operative Society, Agra.

II Un-organised Dairies.

(i) Singhal Dairy, Agra.
(ii) Shankar Dairy, Agra.
(iii) Hari Dairy, Agra.

III Villages around Agra City.

(i) Sikandra.
(ii) Mau.
(iii) Runkata.
(iv) Gailana.
(v) Khandari.
(vi) Gijoli.
(vii) Jawar-ka-Nagla.

In each village five individual producers were selected at random and separate milk samples were collected from each producer from the bulked milk just before its delivery. The samples from the un-organised and organised dairies were collected in the same pattern as mentioned above. Samples were collected from the well mixed lots into sterile stoppered bottles observing the usual aseptic precautions, and transferred to the laboratory with the minimum delay.

Samples were analysed for :—

(i) Total and differential count.
(ii) Direct microscopic count by Breed's method.
(iii) Number of spores of bacteria.

Bacteriological examination of soil and water of the localities from where the milk samples were collected was also done during the survey work to get data which may prove helpful in the present investigation.

Total and differential counts were made by the modified method (Gopal Krishna 1948) while Breed's count was done as recommended by A. P. H. A. (1953). The spore count was done by plating after killing of vegetative cells by immersing the milk samples (in a sterile test tube) in water bath (>80°C) for 15 minutes and cooling to room temperature. Number of micro-organisms in the soil was estimated by plating on Asparagin Mannitol Agar (Thorton 1922) and total count in water was estimated as recommended by A. P. H. A. using standard Agar.

Results and Discussion.

The information obtained in the present study on the quality of milk produced under different conditions has been summarised in Table I.

The higher bacterial count of the village milks and the lower bacterial count from organised dairies is to be expected, considering the conditions of production and handling in these places. This is true in respect of total colony count as well as of D.M.C. Breed's count. Incidentally, the ratio between total count and Breed's count does not show constancy but varied from 1:2·3 to 1:4·3 averaging about 1:3·6. Owing to the spreading type of colonies the spore count could not be done successfully. It is proposed to develop a suitable medium for the purpose.

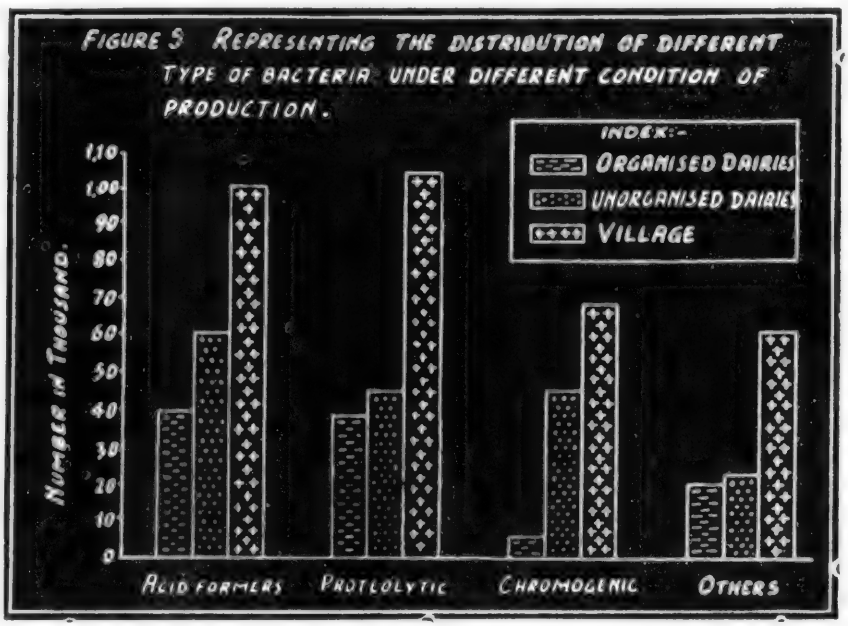

TABLE I

Summary of bacterial quality of milk produced under different conditions.

Source	Acid formers	Proteolytic	Chromogenic	Other types	Total	Breed's Count	Ratio of plate count to Breed Count
Village							
Range (thousands)	3-850	1-650	1-470	0.6-470	50-3870	9616.9	1:3
Percentage of total	11.5	12.3	7.7	68.5	—	—	—
Un-organised Dairies							
Range (thousands)	2-530	3-470	1-206	1-230	49-1289	2829-1103	1:4·3
Percentage of total	36.6	25.8	24.6	13.6	—	—	—
Organised Dairies							
Range (thousands)	1-650	0.5-146	0.7-60	1-230	6-426	566-7354	1:4
Percentage of total	38.0	36.6	6	19.4	—	—	—

Histograms indicate the mean differential count for the types of milks studied.

It is evident that, of the classified typed proteolytic organisms closely followed by acid formers predominate under village conditions. The unclassified group consisted mostly of micrococci and coliform organisms. In contrast to the organised, unorganised dairies had a predominance of acid formers followed by proteolytic.

Hammer (1948) found a count of 4,295 per ml. of milk under sanitary conditions while it was 1,36,533 under unhygienic conditions.

Seshacharyulu (1943) reported 21,11,290 and 13,50,000 bacteria per ml. from village and town dairies (Buffalo milk). Verma et al (1944) reported the range of 5,00,000—10,00,000 and 20,00,000—50,00,000 under village and town dairies milk respeetively for Bangalore area. The results obtained in respect of the differential counts fall within the range reported by Gopal Krishna (1948).

Source	Gopala Krishna (1948)			Present investigation		
	Acid former	Proteolytic	Others	Acid former	Proteolytic	Others
Village	32,290	26,800	2,96,000	1,03,400	1,08,900	6,17,000
Dairy	28,540	43,850	5,72,300	40,900	39,200	21,300

According to milk marketing report a range of 80,000—37,00,000 was observed in Lucknow city milk supply (Market Milk Report 1956).

Considering the wide differences in the management practices followed at different places and the wide variation in climatic conditions, figures obtained in the present work may be said to come within expectation.

The preponderance of proteolysers and chromogenic organisms in the village samples may be explained as follows :—

It was observed that the cleaning of utensils in villages is usually done with mud followed by washing with water, mostly from stagnant pools or from shallow wells. The soil and mud, are well known to contain huge numbers of spore formers and water is one of the primary sources of chromogenic organisms. This can be confirmed by an examination of the soil samples collected from the villages, having an average count of 45 million bacteria/gm with a range of 3–368 millions. The samples of wash water from the villages showed the mean count of 20,000 per ml. In view of this, the large number of these two groups of organisms in village milks is not surprising.

The predominance of acid formers in organised dairies is again to be expected because the utensils form the chief source of lactic acid bacteria (Proctor

1943). Low count of chromogenics can be attributed to the use of a satisfactory quality water (which on examination showed a maximum of 940 bacteria per ml.). The different types of micro-organisms in organised dairies range in between the village and organised dairies. The unorganised dairies often purchase milk from the individual producers from village, pool it and sell it either as such or after standardisation. Naturally the effect of village conditions would have considerable influence on the distribution of microflora of different types.

However, in view of the better sanitation practices in un-organised dairies in comparison with village producers a superiority of milks from former may be expected, though they do not and cannot come upto the standard observed in organised dairies.

Summary :

1. Milk samples from organised dairies were of the highest quality and those from villages of the poorest. Unorganised dairies fall in between the two.

2. Milk from organised dairies predominated in acid-forming organisms while the village samples showed a preponderance of proteolytic and Chromogenic type of bacteria.

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FARM EARNINGS

S. N. Kulshreshtha

Scope :

This paper is based over a Research work done by the author in the village 'Bichpuri', comprising of 30 cases. The selection of the village was done randomly, while the cases were selected by the 'Stratified Random Sampling' method. A list of the cultivators of the village was taken from the Lekhpal and they were classified into four size groups according to the area of land possessed, while selecting, the farmers having land below 2·5 acres were ignored.

Concept of Farm Earnings :

The term farm earnings in this very study is taken to include net return from the cultivation of land and returns from rearing of milch cattle. The net return from land is calculated by deducting the cost of cultivation from the gross income of the farm. Cost of cultivation includes the wages of family workers. Side by side, incomes from any non-farm business, if carried on by the farmer, which was not much common, have also been calculated and represented under the term 'Non-farm earnings.'

Extent of Earnings on different farms :

(a) Net return from different farm size groups :—

Net return on a farm is the difference between gross income of the farm and its cost of cultivation. Gross income is the market value of the produce of the farm while the cost of cultivation includes value of human and cattle labour and materials, engaged in the growing of crops. The following table shows the net return per farm and per acre in Rs. from different farm size groups :—

Group No.	Size group (Acres)	Gross income per farm	Cost per farm	Net return per farm	Net return per acre
		Rs.	Rs.	Rs.	Rs.
A.	2·5—5·0	1045	910	135	36
B.	5—10	2198	1739	459	58
C.	10—15	3422	2451	971	77
D.	Above 15	7049	5091	1958	78
	Average	3429	2548	881	65

The figures given in the above table reveal that the net return per farm and per acre are showing a regular increasing trend with the increase in the farm size group. The net return per farm is Rs. 135 in group A, Rs.450 in group B, Rs. 971 in Group C and Rs. 1958 in the last, being the highest. Like wise the net return per acre is Rs.36 in group A, Rs.58 in group B, Rs.77 in group C, Rs.78 in group D, which is highest. The increase in the last group is more significant due to the increase in the area under commercial crops which are more paying and also due to lower cost of cultivation which is because of fuller utilization of all farm resources (Cattle, Implements, Buildings etc).

(*b*) *Extent of return from milch cattle and other subsidiary occupations :*

Returns from milch cattle represent the income which is received by the deduction of cost of maintenance of milch cattle from the value of milk produced, while the subsidiary occupation includes the most common ones, like hiring labour, running of flour mill, selling milk, shops of various kinds including cycle repair, fruit, vegetable and sweets selling on the near by stations etc. Returns from subsidiary occupation is taken as non farm earnings. The returns from these sources also show wide fluctuations from group to group, which is summed up in the following table :—

S. No.	Size group	Income from Milch cattle per farm in Rs.	Income from subsidiary-occupation per farm Rs.	Total earnings including from crops per farm Rs.
A.	2.5—5	61	47	243
B.	5—10	79	39	577
C.	10—15	182	222	1375
D.	Above 15	134	86	2178
	Average	114	99	1094

It would be observed from the above table that income from milch cattle, first shows increase from A to C group and in the last group it has decreased. This decrease in the last group is because that in this group the income from farm is quite sufficient and thus the farmer is not much anxious to enhance his income from either of the sources to a considerable extent. While in the lower group (A & B) the reason of low income is that the farmer has no money and area to grow fodder to maintain much cattle, above than the milk requirement of the family.

The earnings from both sources in the size group C (10—15 acres) are considerably high, because a case had his business of running a flour mill, and selling milk in Agra city and 2 shops at Bichpuri Station, as a result of which his income from both sources was considerably high and in turn the average of the group also went high.

Returns when analysed on the basis of nature of crops grown, were highest in the case of cash crops i. e. Sugarcane and Potato and lowest in the case of Chari, and Gram.

Improving earning situations :

Earnings in Agriculture may be improved by two types of measures:—

A. Measures increasing the gross Income.

B. Measures reducing the cost of cultivation.

As, we all know that earnings are the difference between the two i.e. Gross income and Cost of cultivation, when we are raising the gross income on one side and lowering the cost on the other, automatically the earnings would be maximized.

A. Measures increasing the gross income :

Gross income is an outcome of the production multiplied by the price, it fetches. In this very study we had assumed a constant price factor for all the cases i. e. to say, we had not taken into account the prices received by the respondents for their respective goods. But still this price factor cannot be neglected while formulating an economic policy for the cultivator. Whole of the situation vests only on this single factor, price. If a particular case is in a position to fetch a better price for his commodities, in comparison to another cultivator, whose production per acre was higher than him, his economic condition would be far better than that unfortunate fellow. So, price measures should be considered an important part of the economic policy and for this aspect price stabilisation, including fixation of ceiling and flour prices with a good administrative machinery can be suggested.

For another important constituent of gross income i.e. production, following measures can be suggested to improve it:—

1. Good and timely tillage operations.

2. Providing irrigation facilities including water lifting appliances, and making of water channels.

3. Improved varieties, evolved after a long research and suitable under the average farmers' conditions should be demonstrated in the area and farmers should be persuaded to adopt those varieties.

4. Provision of suitable plant food in readily avialable form, including the practice of Green manuring.

5. Provision against plant diseases and insect-pests should be made so that the loss incurred by these enemies may be minimized.

Apart from the measures of increasing production, earnings can also be increased by the following measures:—

1. Increasing the intensity of cropping, which would increase the size of farm business and thus increase the income of the farmer.

2. Increasing the area under commercial crops specially vegetables.

3. Increasing the extent of mixed farming i.e. rearing of milch cattle along with the process of cultivation.

4. By adding more non-farm jobs to the farmers specially in the days when they have a period of inactivity.

B. Measures for reducing cost of cultivation :

1. Adjusting the size of farm to optimum size group. In the optimum size group the cost is the lowest, and if the size of the farm is either increased or decreased cost is inflated. In this very study this size lies between 10—15 acres.

2. To keep optimum number of equipment and using them properly to reduce the depreciation and repair cost.

3. Reducing the cost of bullock labour unit on the smaller farm which can be reduced by hiring the bullocks out of holding or to keep joint bullock pairs between 2 or 3 cultivators having small holdings.

4. Increasing the efficiency of hired labour through close supervision and proper training.

By these very measures we can increase the production and gross income on one side and can reduce the cost of cultivation on the other, and then the earnings will ultimately be increased.

SORGHUM HYBRID-SEED PRODUCTION

R. V. S. Singh

Sorghum vulgare Pers, also known in Hindi as "Jowar" is a tall, annual grass. There are several controversies regarding the origin and geographical distribution of this crop. Some believed that Africa has been the birth place of this principal millet-*Sorghum* but Werth (1937) claimed that India has been the native place for the three important millets—viz. *Sorghum, Pennisetum* and *Eleusine.*

In India, the species are so domesticated that the total acreage under this crop comes next to Rice. It occupies 18% of the total cultivable land of the country, yielding 9 million tons. Thus India produces nearly one third of the world harvest. Bombay state is the highest producer in our country.

Among the millets, Jowar (*S. Vulgare* Pers) occupies the premier position because of its drought resistant nature and economic importance of the grain. Its nutritive value, compares favourable with other cereals e.g. it is richer in protein content than rice and in fat content than rice and wheat (Ayyanger 1932). The grain forms the staple food, of the poorer class of people and thus known as poorman's cereal, while the straw is the chief food of nearly 60% cattle population (Rao and Ponnaiya, 1956). Therefore, this grain and fodder yielding millet deserves greater attention in the large-scale production of hybrid seed for the farmer's field.

Sorghum, unlike maize, bears the hermaphrodite minute flowers with a greater degree of self fertilization. Thus the process of hand emasculation during the large-scale hybrid seed production of this crop requires more skill, manual labour and time. Secondly, the mutilation is possible inspite of all the care is taken to the bud. The occurrence of Cytoplasmic male-sterility, however, in *Sorghum* has opened a new avenue in the production of commercial hybrid seed as a quick, cheap (by reducing the cost of pollination) and easy method of increasing the grain and fodder yield (Quinby Martin, 1954 ; Stephens and Holland, 1954 and Duvick, 1959). Cytoplasmic Male-sterility have been also reported in a number of vegetable crops viz. Onion (Jones & Emsweller 1943) and tomato (Roever 1945)

The pioneer work on *Sorghum* has been done by Ayyanger, Ayyar and Rao (1933) ; Ayyanger (1933) ; Ayyanger and Ponnaiya (1936).

First of all Rangaswamy Ayyanger and Ponnaiya (1936) discovered a male-sterile mutant in *Sorghum* at Coimbatore but no stress was made towards its use in breeding. Later on it was reported by Stephens (1937) in a 'Day' *Sorghum* variety. But after 1946 the search for male-sterile sorghum became more popular after the hybrid maize work of Richey and Wallace. Recently Kajjari and Chavan (1953) detected a male-sterile (Cytoplasmic) Jowar in the Yaniger variety (Bombay state).

In view of the recent American work on *Sorghum* through special technique (Stephens and Holland, 1954) plans have been drawn up to produce hybrid seeds with desirable characters by incorporating the sterile cytoplasm into the local *Sorghum* varieties. The need of an extensive investigation along this line has been stressed in the Millet workers Conference at Kolhapur (1955); Pal and Sikka (1956); Rao and Ponnaiya (1956); Argikar and Chavan (1957); Chavan and Shendge (1957) and Reddy (1959).

Materials and Methods :

Sixty three varieties of *Sorghum* collected from U. S. A., U. P. and I.A.R.I. were sown on 15.7.61 in four replications of Row Trial design. Row length was 20 ft. spaced 24 inches apart and the plant to plant distance was 10″. Later on the following observations were recorded.

TABLE I.

Mean values of the Varieties.

Variety No.	Germination %	III Height reading in cms.	Fungus attack in %	Insect infection in %	Time taken in flowering (days)
1	2	3	4	5	6
1.	41·95	104·7	45·6	24·3	62
2.	28·6	47·07	45·0	35·0	64·5
3.	50·4	39·5	32·8	60·3	70·5
4.	39·1	47·5	35·9	16·6	65·7
5.	59·2	134·2	43·3	44·3	61
6.	53·1	57·7	21·4	54·4	93·5
7.	36·2	45·3	41·5	47·3	70·5
8.	27·8	58·1	27·7	31·9	80·0
9.	64·5	94·6	×	×	41·7
10.	65·5	46·9	22·2	44·5	66·7
11.	53·3	69·0	21·4	67·0	86·5
12.	25·5	48·05	33·1	57 6	79·2
13.	16·1	47·1	22·5	100·0	107·7
14.	15·5	44·1	54·7	71·4	72·7
15.	40·1	58·2	52·7	66·0	50·5

Variety No.	Germination %	HI Height reading in cms.	Fungus attack in %	Insect infection in %	Time taken in flowering (days)
1	2	3	4	5	6
16.	55·1	132·7	33·2	55·2	47·7
17.	48·6	95·4	29·1	50·0	49·7
18.	53·0	158·2	31·2	31·6	44·7
19.	60·3	62·6	37·6	18·8	61·0
20.	60·8	70·8	68·7	38·5	59·5
21.	60·2	31·1	22·03	36·7	80·7
22.	62·3	46·05	47·7	45·4	66·2
23.	55·4	37·1	38·4	23·1	73·5
24.	30·2	36·8	45·0	58·3	64·0
25.	52·1	72·5	29·1	100·0	56·7
26.	27·07	36·4	49·5	100·0	91·7
27.	62·1	45·0	39·2	28·02	67·5
28.	69.5	42·1	36·3	28·9	72·0
29.	61·2	40·6	27·1	56·2	66·0
30.	74·3	61·7	23·8	52·9	76·5
31.	54·4	58·3	22·2	43·05	67·2
32.	61·4	67·0	15·4	28·6	77·0
33.	27·6	50·2	18·1	43·1	68·6
34.	21·2	73·7	×	×	61·6
35.	23·2	41·0	37·5	×	89·3
36.	59·8	44·8	57·7	39·9	62·6
37.	57·5	32·2	55·5	38·4	69·3
38.	45·5	31·9	56·06	53·5	78·3
39.	74·03	40·6	44·4	38·03	61·6
40.	44·4	38·8	39·6	25·8	68·0
41.	36·4	35·7	59·05	59·05	78·3
42.	47·5	38·8	42·9	68·1	119·3
43.	71·2	101·5	×	×	42·0
44.	71·6	63·5	50·7	26·6	58·0
45.	33·5	51·5	77·9	44·03	63·6
46.	25·3	44·6	50·0	58·3	80·5
47.	11·2	59·8	×	×	64·0
48.	19·3	63·8	×	×	44·0
49.	5·5	20·1	×	×	75·0
50.	5·3	39·5	×	×	64·0
51.	15·7	24·3	×	33·3	83·0
52.	21·1	22·0	×	×	75·0
53.	10·5	29·5	×	×	96·0
54.	4·7	44·0	×	×	73·0

Variety No.	Germination %	III Height reading in cms.	Fungus attack in %	Insect infection in %	Time taken in flowering (days)
1	2	3	4	5	6
55.	9·5	142·2	×	×	40·0
56.	10·0	99·7	50·0	×	74·0
57.	79·4	72·9	11·1	25·0	87·5
58.	66·7	58·3	8·3	9·0	89·0
59.	79·05	81·2	10·5	5·2	93·2
60.	59·7	64·8	19·06	18·2	90·5
61.	77·9	71·4	×	7·6	89·0
62.	71·05	83·3	14·2	7·1	101·2
63.	60·6	72·02	26·6	×	94·0

Note—Above variety numbers stand for the following varieties.

1. Red seed Sorghum
2. Dwarf Faterita.
3. Sorghum 6645 Hegari
4. Sorghum 1306 Hegari.
5. Hybrid Broomcorn (CK 60 Sorghum × Broom Corn Miller)
6. Broom Corn Remela
7. Sorghum Var. Day (Genetic Sterile 3:1)
8. Sorghum Var. Day (Genetic Sterile 1:1)
9. Hybrid (Male sterile CK 60 × *S. Virgatum*)
10. Broom Corn Var. O' Heir
11. Broom Corn Doggett—1129
12. Sorghum Var. Liguleless
13. *S. Arundinacium*
14. Ross Franzsky (4N)
15. S. Var. Twin Seeded.
16. Tunis grass.
17. Hybrid (CK 60 Male Sterile × Tunis grass.) I
18. Hybrid (CK 60 Male Sterile × Tunis grass) II
19. Hybrid (Male Sterile CK 60 × Shallu)
20. Hybrid (CK 60 × Sweet Sudan grass)
21. Sweet Sudan grass.
22. Hybrid (CK 60 × Dwarf Faterita)
23. Male Sterile Hybrid (Leotic × Martin)
24. Male fertile Martin.
25. Hybrid (Male sterile CK 60 × *S. virgatum*)
26. Texas Red 396
27. Male sterile Redlan
28. Male fertile Redlan.
29. Male sterile Martin
30. Male fertile Martin.
31. Male fertile Texas Blackhull Kafir
32. Male sterile Tex. Bh. Kaf.
33. Red lan.
34. Sudan grass I.
35. Hybrid (2N × 3N *S. Virgatum*).
36. Male fertile Midland.
37. Male sterile Midland.
38. Dwarf Faterita 56 H 5268.
39. Hybrid (CK 60 Midland × Dwarf Faterita)
40. Male fertile Combine Kafir.

41. Male sterile CK.
42. Nebraska 9 E.
43. Hybrid (Male sterile CK 60 X *S. virgatum*)
44. S. Early Kalo.
45. S. Var. Westland
46. Ross Franzsky.
47. Sudan grass II
48. Tunis grass.
49. Dwarf Faterita (4N)
50. S. Var. Scaly.
51. S. Var. Yellow endosperm
52. S. Green striped.
53 Nebraska 610.
54. Dwarf Faterita.
55. Broomcorn Doggett 829.
56. Tunis grass.
57. Jowar 4402 A
58. Jowar 4402 B
59. Jowar 8B
60. Jowar Local Hathras
61. Jowar Local Pratapgarh
62. Jowar Local Bichpuri
63. Jowar Local Kota.

Germination percentage readings were taken so as to see the acclimatization performance of each variety. For this comparison datas are statistically analysed as shown below:—

TABLE II.

Analysis of Variance for Germination percentage.

Variation	D. F.	S. S.	Mean S. S.	'F' value
Between varieties	62	78009·67	1258·220483	3·671069
Within varieties (error)	147	50382·71	342·395938	
Total	209	128392·71	—	—

From the Table of 'F' at 5% level for n1 = 62 and n2 = 14, F = 1·32.

Thus the calculated 'F' value being higher showed that the varieties differ significantly to each other as regards their germination. On the basis of C.D. (25·65) the various distinct groups are shown in Table III.

TABLE III.

S. N.	Varieties showing good germination	Var. showing medium germination	Var. showing poor germination
1.	Jowar 4402A 79·4%	Broomcorn Remela 33·1%	Redlan 829 27·6%
2.	Male Fertile Martin 74·3%	Hybrid (Male sterile CK 60 × *S. virgatum*) 52·1%	Liguleless S. var. 25·5%
3.	Jowar Pratapgarh 77·9%	Combine Kafir-60 Male fertile 44·4%	S. var. yellow endosperm 15·7%
4.	Early Kalo 71·6%	Red seed 41·9%	Nebraska 610 10·6%

Later on, the height readings of each variety, selecting three random plants from each row were taken in centimeters at the interval of 15 days. The last height reading had been taken on 18.9.61 and the datas have been analysed statistically for the comparison of each variety as shown in the following table.

TABLE IV

Analysis of variance for Height.

Variation	D. F.	S. S.	Mean S. S.	'F' Value
Between varieties	62	177730·22	2866·61	2·34
Within varieties (Error)	146	205728·74	1409·11	

From the 'F' at 5% level for n1 = 62, n2 = 146, 'F' = 1·00

Since the table 'F' value calculated is greater than the 'F' value from the table, the observed variations between the varieties are significant. Later on critical difference was calculated, which is 52·01. Thus all the American combine Sorghum plants viz. Early Kalo (63·5 cm.); Male fertile Martin (61·7 cm.); Westland (51·5 cm.); "Day" genetic male sterile seg. 1:1 (58·1 cm.); S. Var. Liguleless (48·1 cm); 1306 Hegari S. (47·5 cm.); S. yellow endosperm (24·3 cm); S. green striped (22 cm.) and Dwarf Faterita 4N (20·1 cm.) showed their much dwarfness in relation to the American Broomcorns viz. Doggett (142·2 cms.), Hybrid (CK 60 S. × Broomcorn Miller) (134·2 cms.); and local Jowar BCH (13·3 cms.); Jowar Pratapgarh (71·4 cms.) and other Indian species (77·3 cms.).

Three local varieties viz. Jowar 4402A, Jowar BCH and Pratapgarh local Jowar were sown in the another field in Randomized fashion into four replications for chemical treatment. Foliar spray was made at a young stage by two gametocides (conc. 0%, ·0025%, ·005%, ·0075%, ·01% 2, 4-D and 0%, ·25%, 5%, ·75%, 1% FW-450), so as to induce male-sterility in these varieties. In case of FW-450 the treatment with (conc. ·75%, 1%) produced burning effect and was more deleterious as compared with 2, 4-D concentration 0·25% and ·5% of FW-450 were less severe and did not show any burning effect. On the whole the treatment with 2, 4-D was not so severe as FW-450. Pollen viability test of the treated material is still under study.

Percentage of the fungus (*Colletotrichum graminicolum*) attack and insect attack (Stem borer i. e. *Chillo-Zonellus* was recorded. The fungus attack was more severe as compared to the insect infection probably due to the continuous rains in July. From statistical calculation for fungus attack the following A. V. Table was prepared to determine the degree of infection shown by different varieties and species of *Sorghum*.

TABLE V

Analysis of variance for % of fungus attack.

Variation	D. F.	S. S.	Mean S. S.	'F' Value
Between varieties	49	8777·40	1791·37	2·84
Within varieties (Error)	69	83441·08	629·58	
Total	118	52218·48	—	—

The 'F' value from the table at 5% level = 1·39

Thus the calculated 'F' value being greater than the 'F' value from the Table shows that the fungus attack between the varieties is more significant. Later on critical difference was calculated i. e. C. D. = 35·48. A comparative study of the varieties for their resistant nature have been made. However, few varieties showed a greater degree of resistance towards the fungus attack viz. Male-sterile Texas Blackhull Kafir 15·4%, Redlan829 18·1%, Jowar BCH 14·2%, Jowar 4402A 11·1% and Jowar 4402B 8·3% as compared to the most susceptible Male-sterile combine Kafir 59·1%; Hybrid (combine Kafir 60 × Sweet Sudan grass) 68·7% and Westland 77·9%. No doubt, a number of varieties have exhibited their resistance towards this fungus. These are as follows :—

1. Sorghum yellow endosperm.
2. Sorghum green striped.
3. Hybrid (Male sterile CK 60 × *S. Virgatum*)
4. Nebraska 610.
5. Sudan grass.
6. Dwarf Feterita.
7. Tunis grass.
8. Broomcorn Dogett.
9. Dwarf Faterita (4N)
10. Hybrid Tunis grass (Double cross between CK 60 × Tunis grass)
11. Jowar Pratapgarh Local.

In the same manner the statistical analysis for the insect infection have been done which showed the following results.

TABLE VI

Analysis of variance for % of Insect infection.

Variation	D. F.	S. S.	Mean S. S.	'F' Value
Between varieties	49	36570·1	746·341020	1·41
Within varieties (Error)	63	45127·55	716·31031	
Total	112	81698·26	—	—

From the Table of 'F' at 5% level for n1 = 49 and n2 = 63, F = 1·39.

Since the calculated 'F' value is greater than the 'F' value from the table, the observed variation between the varieties are significant. Later on C.D. is calculated for the comparative study. (C.D.=37·84). Severe infection have been observed in *S. arundinaceum* (100%), Hybrid (Male sterile C.K. 60 × S. *virgatum*) (100 %), Ross Franzsky (4N) 71·4% ; Liguleless 57·6% ; Male sterile Martin 56·2% and Broomcorn Remela 54·4%. However, few varieties viz. Jowar 4402B 9%; Jowar 8B 5·2%; Jowar BCH 7·1%; Jowar Pratapgarh 7·6%; showed the least insect infection. Inspite of all these deviations few varieties showed their 100% resistance towards the insect infection, which are as follows:—

1. Sorghum green striped.
2. Nebraska 610.
3. Sudan grass.
4. Dwarf Faterita.
5. Broomcorn Dogett.
6. Jowar Kota Local etc.

From Tables V and VI it became clear that the following varieties showed their 100% resistance towards the fungus attack as well as the insect attack.

1. Sorghum green striped.
2. Nebraska 610.
3. Sudan grass.
4. Broomcorn Doggett.
5. Hybrid Tunis grass (Double cross CK 60 × Tunis cross) etc.

The aforesaid 100% resistance varieties will be utilized in our breeding programme next year, so as to produce the resistance hybrid seeds.

At the stage of flowering, flowering dates were noted for each variety. The datas regarding days taken for flowering for each variety have been statistically analysed which is given in the following table.

TABLE VII

Analysis of variance for the time taken in flowering.

Variation	D. F.	S. S.	Mean S. S.	'F' Value
Between varieties	62	53104·41	856·522741	8·81
Within varieties (Error)	147	14202·59	96·616 2585	
Total	209	67307·00	—	—

From the Table 'F' at 5% level for N1 = 62 and N2 = 149, F = 1·32.

Thus the 'F' value calculated is very high showing the significant differences in flowering dates between the varieties. Later on C.D. is calculated (i. e. 13·54) for individual comparison. Few varieties have shown their earliness viz. Broomcorn Doggett (40 days) Hybrid Sorghum (CK 60 × Dwarf Faterita) 66 days, Early Kalo (58 days); Hybrid (Male sterile CK 60 × *S. Virgatum*) 56 days; over local varieties viz. Jowar BCH (101 days); Jowar Kota (94 days) Jowar Pratapgarh (89 days).

Various hybridization have been made with local Jowars' varieties and with other Indian varieties so as to incorporate earliness and cytoplasmic male sterility. A special technique for hot water bulk emasculation have been devised. Hot water at 49°C was poured in the bag around the local *Sorghum* panicle and kept closed for 10 minutes, which resulted in the complete killing of the pollen grains.

Summary :

Performance trial of 63 varieties of *Sorghum* have been made as regards their germination, drought, fungus and insect infection and lastly the days taken in flowering. Three selected varieties have been treated with two chemicals for the induction of male sterility. Crosses have been made with the local varieties for disease resistance, earliness and to transfer the sterile cytoplasm in them.

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PRELIMINARY REPORT ON THE BREEDING OF HYBRID PENNISETUM.

Yadvendra Prakash Sharma.

Pennisetum is one of the important genera of the family Gramineae, subfamily Panicoideae and the tribe Paniceae. Most of the members of the genus are annual herbs and are distributed throughout India. A few of the species are cultivated for grain and fodder but many of them are wild.

P. typhoideum is one of the major food grain crops for the poor people and also provides fodder for the animals. The total area under millet cultivation in India is 85 million acres out of which one third is occupied by Bajri. Though *P. typhoideum* is cultivated so extensively in India; yet its yield is very low. The crop is susceptible to various insect—pests and fungus diseases. Any information of work which will be helpful in the improvement of Bajri will be of great value for Bajri cultivators. Therefore a programme of improvement of Bajri has been initiated. As Bajra is a cross pollinated crop exploitation of hybrid vigour affords a promising line of research in the improvement of the crop. This line of approach has two main problems :—

1. Isolation of desirable inbreds which are to be used in crossing for hybrid seed production.

2. To induce male sterility in the selected inbreds to insure crossing between two selected inbreds. Cytoplasmic male sterility discussed in *P. glaucum* (Burton, 1958) will be the source for the transfer of male-sterility to the local Indian stock.

In recent years certain chemicals have also been used by a number of workers to induce male-sterility in some crop plants like tobacco, maize, cocklebur (Naylor 1950 a, b), cucurbits (Wittiver and Hillyer, 1954), cotton (Eaton, 1957, Meyer, Roux, and Thomas, 1958), tomato (Moore, 1959), sorghum, (Miller, 1961.) These chemicals are believed to kill pollen and pollen mother cell without injuring the female parts if applied in proper concentrations. Such chemicals are known as the gametocides. Chemicals so far tested as gametocides are—

1. Maleic hydrazide
2. FW 450
3. 2,3—dichloroisobutyric acid.
4. 2:2—dichloropropionic acid.

In addition to these some other chemicals most of which are herbicides have also been tested for acting like a gametocides.

1. Aminotriazole.
2. Dowpon.
3. 2,4—D.B.
4. 2,4—D.
5. D. N. B. P.
6. Sesone.
7. 4 Flourophenoxyacetic acid.
8. 2 Chloro, 4 Flourophenoxyacetic acid.
9. 4 Flourophenoxy alphapropionic acid.
10. aBB trichloroisobutyric acid. etc.

But they have produced more toxic effect than working as gametocides particularly in case of *Sorghum*.

In the present work an attempt is made to induce male sterility in *Pennisetum* by means of Maleic hydrazide, 2,4—D and FW 450.

The following is the detail plan of work on breeding, cytogenetics and morphology of the genus *Pennisetum*.

1. Morphological studies of all the different parts of the plant along with their developmental studies.

2. Anatomical studies of the floral and vegetative parts of different species of *Pennisetum*.

3. Embryological studies including the development of seed and the structure of the seed coat.

4. Cytological studies including the karyotypic studies and the behaviour of the chromosomes during meiosis and mitosis.

5. Technique of hybrid seed production with reference to the male-sterile lines along with the developmental studies, morphological cytological details of the male fertile and male—sterile lines.

6. Cyto—and Histochemical studies with reference to the localization of alkaline phosphatase, nucleic acid and other important enzymes in flowers and caryopsis.

7. Breeding methods:—

(a) Technique for maintaining the male—sterile line and transfer of the male-sterility in the Indian types.

(b) Interspecific crosses for certain desirable characters and the morphological and cytological details of the hybrids.

8. The use of the gametocides. Chemical emasculation of the flower without effecting the female parts with reference to:—

(a) Application of Maleic hydrazide, 2,4—D. and FW.—450 in different concentrations on a selected number of the standard varieties of *Pennisetum typhoideum*.

(b) Developmental and cytological details of the treated and untreated plants.

(c) Effects on the male and female parts of the flower.

(d) Effect of the chemical—on the growth of the plant.

Details of the work done :—

On July 18, 1961 the following species and varieties of *Pennisetum* were sown in randomized block design in five replications. In the field the distance between the rows was 1·5 feet while in between the plants was 10 inches.

Name of the species	Name of the variety	Obtained from
1. P. typhoideum	1. Bajra local, Agra.	B. R. College Farm
	2. Bajra inbred 18 Kanpur.	Kanpur.
	3. Improved ghanna.	I. A. R. I., Delhi
	4. Rajasthan Bajra desi.	Rajasthan.
	5. „ „ Jakhrana.	„
	6. Bajra Local Kota.	Kota.
	7. „ „ Pratapgarh.	Pratapgarh.
	8. „ „ Aligarh.	Aligarh.
	9. „ isolated.	
2. P. glaucum.	1. Male-fertile line.	Georgia (U. S. A.)
	2. „ -sterile „	„ „
3. P. villosum.		I. A. R. I. New Delhi.
4. P. pedicellatum.		„
5. P. orientale.		„
6. P. polystachyon.		„

The seeds of the last four species of *Pennisetum* were sown in the Botanical Garden of the College. *P. pedicellatum* germinated quite well, while the remaining three did not germinate at all.

In the experimental field the seeds of *P. villosum* did not germinate while the CMS* *P. glaucum* showed very poor germination. The percentage of germination was recorded for all the species and varieties in all the five replications. The height of the plants in each row was also taken at a regular interval of one week and 15 days to see the rate of growth in different species and varieties of *Pennisetum.*

The flowering was observed first in Improved Ghanna on 28-8-1961. The time taken by all the species and varieties for flowering from the date of showing was also observed.

At the time of flowering three plants from the each row were selected for the developmental studies and the following observations were made:—

1. Date on which the first panicle appeared.
2. Date on which the panicle came out completely.
3. Date on which the stigma receptivity started.
4. Date on which the stigma receptivity was over.
5. Date on which the anthers started dehiscing.
6. Date on which the anthers dehisced completely.
7. Time for which the pollen grains remain viable.

When the pollen grains of some species and varieties were available and the stigmas were also receptive the reciprocal, as well as the simple crosses were made. Some of the Indian varieties of *P. typhoideum* were crossed as a male parent with CMS *P. glaucum* as a female parent to produce the CMS in Indian types. Reciprocal crosses of *P. glaucum* and *P. typhoideum* (including all the available varieties) were made to get the inter specific hybrids. Among the different varieties of *P. typhoideum* also reciprocal crosses were made. The hybridization was facilitated by the protogynous condition of the flower which eliminated the work of hand emasculation.

To obtain the inbred lines in different varieties and species selfing was also done. Bajri is a cross pollinated crop, so for getting the selfed seeds, the bags were tried to some of the panicles in each row, before its stigma was receptive. In this way the contamination from the foreign pollens was checked and selfed seeds were obtained.

The crop is susceptible to various fungus diseases and insects. Luckily the insects did not do any damage to the crop. But the fungus *Sclerospora graminicola* responsible for the green ear disease of Bajra infected 7·42% of plants, while the *Tolyposporium penicillarie* casual organism for smut of Bajra on the whole attacked 88·38% plants, and caused the greatest damage.

* Cytoplasmic male-sterile.

Before harvesting, three plants in each row were selected at random and the final length was measured. This length was summarised in a tabulated form for all the species and varieties. The statistical calculations show that the difference in the height of the plants between the varieties is significant as it is shown in table I.

TABLE I.

S. N.	Factor	S. S.	Degrees of freedom	Variance	F
1.	Total	54269·5	54		
2.	Treatment	29711·7	10	2971·17	5·323
3.	Error	24557·8	44	558·13	

The difference between the varieties is significant because the calculated 'F' value (5·323) is more than the 'F' value from the Fischer "Table 2·06 at ·05 level of probability and 44 degrees of freedom."

On the basis of C.D. = 29·88 shows that the American strains *P. glaucum* fertile and sterile lines are shortest in plant height while K18 and Bajra isolated are longest. The remaining ones have normal height (see table II).

TABLE II.

S. N.	Variety	Critical Difference	Meanlength in C. M.	
1.	P. glaucum	29.88 C. M.	70·00	Shortest
2.	P. glaucum CMS.		92·00	
3.	Jakhrana Local		115·00	
4.	Desi Local		118·40	
5.	Kota Local		121·20	
6.	Improved Ghanna		122·80	Normal
7.	Pratapgarh Local		136·00	
8.	B. C. H. Local		138·40	
9.	Aligarh Local		142·40	
10.	Kanpur inbred 18		148·40	Longest
11.	Bajra isolated		149·00	

Correlation of Panicle height and plant height is also under study.

The following three varieties of *P. typhoideum* were sown on July 28, 1961 for the use of gametocides.

1. Improved Ghanna.
2. Bajra Kanpur Inbred 18
3 Bajra Local from B.R.C. Farm.

The plan was two treat these plants in rows with the chemicals 2,4—D FW. 450 in the four different concentrations of 0·25%, 0·5%, 1·0% and 1·5%. The treatment was to be done by spraying the chemical by hand sprayer at least three times before the flowering. But due to heavy rain just after the sowing of the seeds the germination was very poor and plants could not be treated in rows, as planned, hence individual plants were selected for treatment from different rows, and only one application of the chemical was given when the plants were approximately of 40 to 70 c. m. high.

The application of low conc. 0·25% did not effect the plants apparently, while the higher conc. burnt the main stem and did not allow it to develop any further, slightly later, however, tillers come out. In some of the cases the chemical proved to be injurious for the roots and the plants laid down on the earth but the panicles were formed. The panicles had the vertical position at right angle to the main stem or axis. Preliminary observations show promising results with gametocides in inducing male sterility in *Pennisetum*.

Summary.

A programme for the production of hybrid seeds in Pennisetum has been initiated. On July 18, 1961, 6 different species of *Pennisetum* and 9 varieties of *P. typhoideum* including male-sterile and male-fertile line of *P. glaucum* were sown in randomized block design at Bichpuri Farm. At regular intervals of 7 days the length of the plants in each replication was measured to see the rate of growth. Time taken for each variety to flower was also observed. At the time of blooming developmental studies regarding the opening of the flower, anthesis, pollination and stigma receptivity was also recorded. Many interspecific and intervarietal crosses were made. As the crop is susceptible for the fungus diseases percentage of the diseased plants was also recorded. On the average 7·42% plants were attacked by the fungus *Sclerospora graminicola* responsible for the Green ear disease of Bajra, and 88·38% plants in the smut disease of Bajra caused by *Tolyposporium penicillarieae* was observed. Before harvesting the crop the final length of the plants and Panicles was observed. The statistical calculations showed that the plants of all the varieties and species differ significantly in their length.

Plants were treated with 2,4—D, and FW—450 and maleic hydrazide to induce male sterility. The low concentration of the chemical had no apparent effect on the plant while the higher concentrations proved to be injurious.

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SOME OBSERVATIONS ON THE HOST-PLANTS OF MEMBRACIDS (HOMOPTERA, MEMBRACIDAE)

B. S. Chandel.

Introduction :

There is hardly any satisfactory record about the host-plants of Indian membracids. The contributions of Distant (1908—16), Lefroy (1908), Chatterjee & Bose (1933), Ratanlal (1948), Behura & Sinha (1951), Behura (1951), Panda & Behura (1956 & 57), and author (1959), although important, do not give a comprehensive list. The author has, therefore, endeavoured to give a list of species of membracids along with their host-plants from which they have actually been collected during feeding. His observations were mainly confined to Agra, Aligarh and Mainpuri districts of U. P. (India).

Observations :

The following six species of membracids were collected by the author from the above mentioned localities :

(*1*) *Oxyrhachis tarandus* Fabr.
(*2*) *Leptocentrus taurus* Fabr.
(*3*) *Leptocentrus* Sp.
(*4*) *Gargara varicolor* Stal.
(*5*) *Otionotus oneratus* Walk.
(*6*) *Tricentrus subangulatus* Dist.

The table No. 1 gives the names of the various species and their life stages along with the different host-plants found during the course of the year.

Discussion :

It is clear from the following observations that these insects are found only on dicot plants numbering fifty one and spreading over twenty one families (Leguminoseae 34%, Solanaceae 10%, Moraceae 14%, Myrtaceae 8%, Capparidaceae 6%, Rhamnaceae 4% and rest 30%). It is, thus, significant to note that these tree-hoppers like leguminous plants most.

Table No. 1. Giving the names of the various species & their life stages along with the different host-plants.

Vernacular Name	HOST—PLANTS Botanical Name	Family	Name of Membracid	Stage	Season
1. Am	*Mangifera indica* Linn.	Anacardiaceae	*O. tarandus*	Adult	Rains
2. Karaunda	*Carisa carandas* Linn.	Apocynaceae	*O. oneratus*	Adult & nymph	do
3. Ashok	*Polyalthia longifolia* Benth.	Annonaceae	do	do	Summer & rains
4. Sharifa	*Anona squamosa* Linn.	do	do	do	do
5. Lissora	*Cardia myxa* Linn.	Boraginaceae	do	Adult	Summer
6. Tendo	*Dios yros* sp. Linn.	Ebneceae	*L. taurus*	Adult & Nymph	Rains
			L. sp.	do do	do
7. Ambla	*Phyllanthus emblica* Linn.	Euphorbiaceae	*L. taurus*	Adult	Summer
8. Karil	*Capparis aphylla* Roth.	Capparidaceae	*L. taurus*	Adult & Nymph	Rains
			O. oneratus	do do	do
9. Aundi	*Capparis sepiaria* Linn.	do	*L. taurus*	do do	Winter & Sum.
10. Barna	*Cretaeva religiosa* Forst.	do	do	do do	Rains
11. Kachnar	*Bauhinia variegata* Linn.	do	do	do do	do
12. Amaltas	*Cassia fistula* Linn.	Caesalpinioideae	*O. tarandus*	do do	Whole year
		do	*O. oneratus*	do do	do
13. Babool	*Acacia arabica* Willed.	Mimosoideae	*O. tarandus*	do do	do
			O. oneratus	Adult	Summer & Rains
14. Jhand	*Prosopis spicegera* Dc.	do	*O. tarandus*	Adult & nymph	Whole year
15. Kikar	*Prosopis juliflora* Dc.	do	*O. tarandus*	do do	do
			O. oneratus	do do	do
			G. varicolor	do do	Rains

Vernacular name	HOST—PLANT		Name of Membracid	Stage	Season
	Botanical Name	Family			
16. Jangal Jalebi	*Inga dulcis*	do	*O. tarandus*	Adult & nymph	Whole year
			O. oneratus	do do	do
17. Siris	*Albizzia lebbek* Benth.	do	*O. tarandus*	do do	do
			O. oneratus	do do	do
18. Jait	*Sesbania aegyptiaca* Pers.	Papilionatae	*O. tarandus*	Adult & nymph	Whole year
			O. oneratus	do do	do
			L. taurus	do do	do
			L. sp.	do do	Rains
			G. varicolor	do do	Whole year
			T. subangulatus	Adult	Summer
19. Sem	*Dolichos lablab* Linn.	do	*O. tarandus*	do	Winter & Sum.
			G. varicolor	Adult & nymph	do do
			L. taurus	do do	Summer
			T. subangulatus	Adult	do
20. Sanai	*Crotalaria juncea* Linn.	do	*O. tarandus*	Adult & nymph	Winter
21. Arhar	*Cajanus indicus* Spring.	do	do	do do	do
			G. varicolor	do do	Win. & sum.
			O. oneratus	do do	do
22. Shisham	*Dalbergia sissoo* Roxb.	do	*G. varicolor*	do do	Whole year
23. Jawasa	*Alhagi camelorum* Fisch.	do	do	do do	Summer
24. Imli	*Tamarindus indica* Linn.	do	*O. tarandus*	do do	Rains
			O. oneratus	do do	do

Vernacular Name	HOST—PLANT		Name of Membracid	Stage	Season
	Botanical Name	Family			
25. Barsim	*Trifolium alexandrium*	Papilionatae	*L. taurus*	Adult	Winter
			G. varicolor	do	do
26. Mehndi	*Lawsonia inermis* Linn.	Lythraceae	*L. taurus*	Adult & nymph	Rains & Win.
			L. sp.	do do	Rains
27. Kapas	*Gossypium herbaceum*	Malvaceae	*L. taurus*	Adult	Winter
	F. B. I.		*O. oneratus*	do	Summer
28. Sanjana	*Moringa pterygosperma*	Moringaceae	*O. tarandus*	do	do
			L. taurus	do	do
29. Bargad	*Ficus benghalensis* Linn.	Moraceae	*O. oneratus*	do	Rains
30. Pipal	*Ficus religiosa* Linn.	do	do	Adult & nymph	do
31. Gular	*Ficus glomerata* Roxb.	do	*L. taurus*	do do	Whole year
32. Pakhar	*Ficus infectoria* Roxb.	do	do	do do	Rains
33. Shahtut	*Morus alba* Linn.	do	do	do do	do
34. Shahtut (black)	*Morus nigra* Linn.	do	do	do do	do
35. Anjir	*Ficus carica* Linn.	do	do	Adult	Summer
36. Jamun	*Eugenia jambolana* Lamb.	Myrtaceae	do	Adult & nymph	do
37. Gulab-jamun	*Eugenia jambosa* Linn.	do	do	do do	do
38. Amrud	*Psidium gua java*	do	*O. oneratus*	do do	do
39. —	*Eucalyptus sp.* Herit.	do	do	do do	Summer & Rains

Vernacular Name	HOST—PLANT		Name of Membracid	Stage	Season
	Botanical Name	Family			
40. Ber	*Zizyphus jujuba* Lamb.	Rhamnaceae	*O. tarandus*	Adult & nymph	Summer & Rains
			O. oneratus	do do	Summer
			O. taurus	do do	Summer & Rains
			L. sp.	do do	Rains
			G. varicolor	do do	Summer
41. Jharberi	*Zizyphus rotundifolia* Lamb.	do	*O. tarandus*	Adult	Winter
42. Bel	*Aegle marmelos* Correa.	Rutaceae	*L. taurus*	Adult & nymph	Win. & Sum.
			L. sp.	Adult	Rains
43. Mittha	*Citrus medica* Linn.	do	*O. oneratus*	Adult & nymph	do
44. Badam	*Prunus amygdalus*	Rosaceae	*O. oneratus*	do do	do
45. Chandan	*Santalum album* Linn.	Santalaceae	*O. oneratus*	Adult	Whole year
46. Kala dhatura	*Dhatura fatuosa* Linn.	Solanceae	*L. taurus*	Adult & nymph	Summer
47. Baigon	*Solanum melongena* Linn.	do	*O. tarandus*	Adult	Summer
			L. taurus	Adult & nymph	Winter
48. Aloo	*Solanum tuberosum* Linn.	do	*L. taurus*	Adult	Winter
			G. varicolor	do	do
49 Makoi	*Solanum nigrum* Linn.	Solanaceae	*G. varicolor*	Adult	Winter
50. Asgand	*Withania somniferaunal*	do	do	Adult & nymph	Win. & Sum.
51. Phalsa	*Grewia asiatica* Linn.	Tiliaceae	*G. varicolor*	do do	do do
			L. taurus	do do	do do

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CONDENSATION OF ALDEHYDES WITH PHENYLACETIC ACID.

R. N. Singh and N. L. Zutshi.

PART IV—Condensation of 5—Bromo—and 3 : 5–dibromosalicylaldehydes with phenylacetic acid.

Condensation of 5—Bromo-salicylaldehyde and 3 : 5—dibromo-salicylaldehyde with phenylacetic acid has been effected. The products obtained from the two aldehydes are 6—Bromo—3—phenylcoumarin and 6 : 8-dibromo-3—phenylcoumarin. Bases like pyridine and piperidine individually as well as in mixture, in traces as well as in molecular proportions, were used as catalysts. In the case of 5—Bromosalicylaldehyde piperidine was found to be a better catalyst while pyridine yielded better results with 3 : 5—dibromosalicylaldehyde. The substitution of bromine in the benzene ring has exercised a positive influence on the condensation reactions.

In parts I[7],II[8] and III[9] of this series the genesis of Perkin's reaction and the modifications it underwent from time to time have been described. The large volume of work done on Perkin's and Knoevenagel's reactions shows that the various factors, that influence the speed of the reaction, the quality and quantity of the yield, include the temperature at which the reaction is carried on, the duration of heating, the catalyst used, and the groups present on the reactants.

In the present investigation the component containing the reactive methylene group is phenylacetic acid which has been condensed with 5—bromosalicylaldehyde and 3:5—dibromosalicylaldehyde. Pyridine and piperidine alone as well as in mixture have been used as catalysts. The investigation involves the study of the effect on condensation of two different groups, hydroxy and haloid, when together present on the benzene ring in the aldehyde component.

Mono and disubstitution of bromine in salicylaldehyde and the condensation of these bromo aldehydes with phenylacetic acid definitely shows the favourable effect of bromine on the condensation and thus suppresses the inhibitory effect of the hydroxy group, although the yield of the condensation product decreased in the case of 3:5—dibromosalicyladehyde as compared to 5—bromosalicylaldehyde. This may be attributed to the fact that bromo compounds do not stand higher temperatures, particularly, when there are two or more bromine atoms in the molecule. Thus the low yield is probably due to the loss by decomposition at the high temperature of 180° C used in this case. Pyridine trace method did not prove of much use in the condensation of 5—bromosalicyl-

aldehyde with phenylacetic acid, whereas it gave 35·2% yield with 3:5—dibromo salicylaldehyde when condensed with phenylacetic acid. In the case of 5—bromo salicylaldehyde with phenylacetic acid a maximum yield of 67% was obtained when piperidine was used as a catalyst.

The results of this investigation show that on the whole the substitution of bromine atoms in the benzene ring has got a positive influence on the course of condensation. The low yield in the case of dibromosalicylaldehyde does not run contrary to the above inference as at the high temp. of 180°C the condensation product undergoes decomposition to some extent. The success of pyridine in one case and that of piperidine as condensing agent in the other further confirms the irregular efficiency of the various bases as catalytic agents, a fact already described by Pandya and Vahidy.[4]

It remains to be seen how will acetic anhydride alone or in mixture with tertiary bases influence the above reactions. It has done well in some other cases.

EXPERIMENTAL

Preparation of 5—Bromosalicylaldehyde[1, 5] :—

5 gms. of salicylaldehyde dissolved in 9·6 c. c. of glacial acetic acid were placed in a freezing mixture and a solution of bromine (6·6 gms.) dissolved in an equal volume of glacial acetic acid was added drop by drop with constant stirring. 5—Bromosalicylaldehyde was immediately precipitated which was washed and dried (yield 82·5%). The product was recrystallised from dilute alcohol, 40% alcohol gives best results. It is advisable to effect the crystallisation in fractions and mix up the crops of the same melting point. The crystallised aldehyde melted at 105°C.

Condensation of 5—bromosalicylaldehyde in presence of pyridine:—

0·73 gms. of 5—Bromosalicylaldehyde and 0·5 gms. of phenylacetic acid (1 : 1 mol.) were taken in a 50 c.c. R.B. flask and four drops of pyridine (0·15 mol.) were added. Heated it for six hours on an oil bath at 180°C and allowed to stand overnight. The contents of the flask were then treated with hot 10% solution of sodium bicarbonate to dissolve the unreacted acid and filtered. The residue was treated with ether and vigorously shaken to dissolve the aldehyde and filtered. The residue on the filter paper was the condensation product. Yield 0·3 gms. i.e. 29% of the theoretical. Bromine found 26·51%; 3—phenyl 6—Bromo coumarin, $C_{15}H_9O_2$ Br, requires 26·6%.

With piperidine as catalyst :

The same amounts of 5 Bromo—salicylaldehyde and phenylacetic acid were heated using piperidine as a catalyst. Several experiments were performed at temperatures ranging between 100 and 180°C for 6, 9 & 12 hours. The optimum

conditions were when the aldehyde, phenylacetic acid and piperidine in molecular proportions (1:1:0·15) were heated at 180°C for nine hours. Lower temperatures and longer hours of heating reduced the yield. The reaction mixture was allowed to stand overnight and the product extracted in the usual way. The condensation product weighed 0·72 gms. The yield was 67% of the theoretical.

Robinson and Shinoda's[6] and Fritz Vorsatz's[2] methods failed to effect condensation.

Pyridine-piperidine mixture trace as catalyst :—

0·73 gms. of 5—Bromo salicylaldehyde, 0·5 gms. of phenylacetic acid, two drops of pyridine and two drops of piperidine (1:1 : 0·075 : 0·075 mol.) were heated at 180°C for nine hours and allowed to stand overnight. The extraction was done as usual. The condensation product weighed 0·58 gm. i.e. 54% of the theoretical.

The condensation product was crystallised from benzene and was found to melt sharply at 193°C. It was identified as 3–phenyl–6–bromocoumarin.

Condensation of 3 : 5—dibromo salicylaldehyde with phenylacetic acid :

Preparation of 3 : 5—dibromosalicylaldehyde[3] :—

17·5 gms. of bromine (a little more than 2 mol. proportion) was added to 5 gms. of salicylaldehyde in 100 c.c. R. B. flask drop by drop with vigorous shaking. The flask was kept at room temperature for two days with occasional shaking. On the third day the whole mass had set to a solid. This was taken out with about 500 c.c. or more of water ; filtered and washed the excess of bromine with water. It was recrystallised from dilute alcohol (80% gives better results) ; crystallisation, if effected in fractions, becomes easier. It melted at 82 to 84°C, yield was about 87% of the theoretical.

Condensation of 3 : 5–dibromosalicylaldehyde with pyridine as condensing agent :—

0·5 gms. of phenylacetic acid 1·03 gms. of 3:5–dibromosalicylaldehyde and 4 drops of pyridine in molecular proportions (1:1:0·15) were heated at 100°, 120°, 140°, 160° and 180°C for six hours in different experiments. The optimum conditions were when the reactants were heated at 180° C for six hours. Allowed to stand overnight. Then treated with 10% soln. of sodium bicarbonate to dissolve unreacted acid. The residue was then treated with ether to dissolve out unreacted aldehyde and filtered. The residue on the filter paper weighed 0·48 gms. i.e. 35·2% of the theoretical. The crude product is brownish in colour, if washed with acetone it becomes almost colourless. The pure sample obtained by crystallisation through benzene is almost colourless and melts at 196°C. Bromine found 41·89 ; 3–phenyl–6:8–dibromocoumarin, $C_{15}H_8O_2Br_2$ requires 42·1%.

With piperidine trace as catalyst :

0·5 gm. of phenylacetic acid, 1·03 gm. of 3:5-dibromosalicylaldehyde and 4 drops of piperidine (1:1:0·15 mol.) were heated at 100°, 120°, 140°, and 160°C for six hours. Allowed to stand overnight and extracted as usual. Maximum yield of 14·6% was obtained at 140°C with six hours of heating. At 160°C no product could be obtained due to charring ; further increase in duration of heating did not improve the yield. Pure product obtained by crystallising through benzene melts at 196°C.

Pyridine-piperidine mixture trace as catalyst :—

0·5 gm. of phenylacetic acid, 1·03 gms. of 3:5-dibromosalicylaldehyde in molecular proportion (1:1) and two drops each of pyridine and piperidine (0·075 mol. of each) were heated in a R. B. flask at 100°, 120°, 140°, 160° and 180°C for six hours. The contents of the flask after allowing to stand overnight were extracted as usual. At optimum conditions, six hours of heating at 180°C, gave 15·2% yield of the condensation product. Further increase in heating did not improve the yield.

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CLASSIFICATION OF THE THESES

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7	Condensation of o—chlorobenzaldehyde with phenylacetic acid.	1953
8	Condensation of phenylacetic acid with vanillin and 5—bromovanillin.	1954
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18	Condensation of piperonal with phenylacetic acid.	1958

S. N.	Title of the Theses	Year
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24	Condensation of 3:5–di-iodosalicylaldehyde with p-Nitro-phenylacetic acid.	1959
25	Condensation of 6—Bromopiperonal with hippuric acid.	1959
26	Condensation of 5—Bromovanillin with p-Nitrophenylacetic acid.	1959
27	Condensation of 6—Bromopiperonal with phenylacetic acid.	1959
28	Condensation of Vanillin with p-nitrophenylacetic acid.	1959
29	Condensation of 5—Chlorosalicylaldehyde with glycine.	1960
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31	Condensation of p-chlorobenzaldehyde with phenylacetic acid.	1961
32	Condensation of 5—Bromosalicylaldehyde with glycine.	1961
33	Condensation of 3:5–dichlorosalicylaldehyde with glycine.	1961
34	Condensation of 3:5–dibromosalicylaldehyde with glycine.	1961
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38	Study of chromous salts.	1953
39	Reduction of dyestuffs with chromous sulphate.	1958
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41	Paper chromatographic studies on cations using inorganic aqueous eluents.	1962
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43	Studies on coagulation of solutions by observing conductivity and surface tension change during time of coagulation by addition of electrolytes.	1952
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